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## CALIFORNIA HYDRAULIC MINING UNDER THE CAMINETTI ACT.

THE gold deposits of California are, for a large part, contained in gravel beds once the channel of rivers which formed the drainage of the west slope of the Sierra Nevada Mountains. In the course of ages new rivers were formed, leaving the ancient gravel beds elevated often hundreds of feet above the river beds of the present. The depth of the gravel in the old channels is often several hundred feet and the width across them frequently one-half mile, while their courses may be traced for thirty or forty miles in length in detached sections which are the remnants of once continuous beds. Denudation and the cutting down of the present streams has removed parts of the ancient channels and they often disappear below the surface for several miles underneath coverings of lava which have been spread over them.

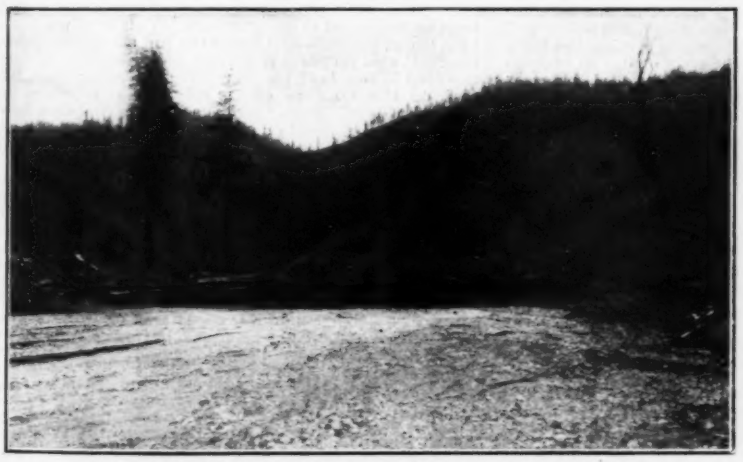
The gold occurs distributed more or less irregularly, and varies in size from microscopic particles to nuggets several ounces in weight. It often occurs concentrated in rich layers near the bottom of the beds, and when this is the case, especially where there is a covering of lava too thick to make its removal profitable, tunnels are run along the bed rock and side workings extended from these, only a layer a few feet thick of the richer gravel being removed, the upper mass being left in position. This method is known as drift mining. There are often acres of ground honeycombed in this manner, supported upon timbers and upon pillars of the gravel which it would be unsafe to remove. Gravel yielding $1.00 per ton and upward may be mined in this manner.

Where the gravel extends to the surface, the whole depth of the deposit is removed and the method followed is that termed hydraulic mining. A vertical bank is first exposed and a large flow of water carried in an iron pipe under heavy pressure is discharged through nozzles in jets directed against the base of the gravel bank and used to undermine it. The gravel and the water are afterward carried off in wooden flumes frequently a mile in length, in passing through which the gravels are broken up and washed, the gold lodging in interstices in the paving of the flumes, or, when small in size, is caught by particles of quicksilver distributed along the flume to catch it. The use of water in this manner was a gradual development. It was first used upon a small scale shortly prior to 1860. The first nozzles were but slightly larger than garden hose jets, but in course of time were increased in size until jets eight and nine inches in diameter were used. When operations are upon a large scale, gravel deposits yielding five cents per cubic yard, and less, have been mined profitably by this method.

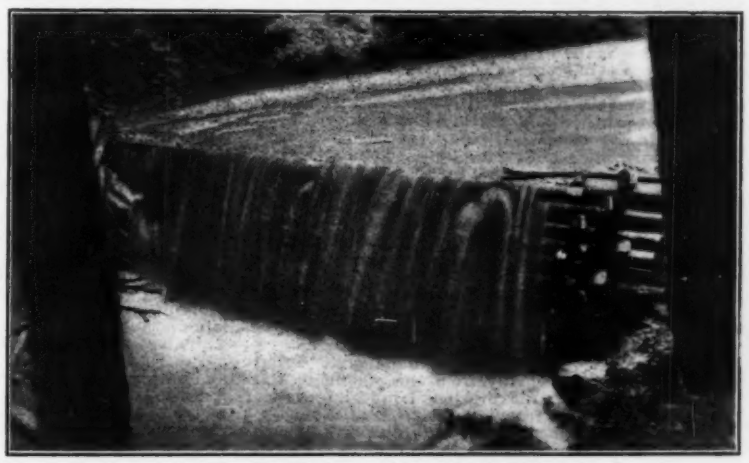
MONITOR IN OPERATION AGAINST A 300-FOOT BANK.

Hydraulic mining became an immense industry. At the time when it had reached its greatest development it was estimated that more than one hundred millions of dollars had been invested in the construction of water supplies, mining plant, tunnels, and flumes, and more than two million dollars have been spent in the equipment of a single mine. Everything was upon an immense scale, and the amounts of gravel removed were in proportion. So large, in fact, that the material washed into the streams caused blockages overspreading agricultural lands in the Sacramento Valley, obstructing and raising the beds of the navigable rivers which enter San Francisco Bay, causing inundations at times of flood, and generally making its influence noticeable 200 miles from the seat of mining. In 1880 it was estimated that in the bed of the Yuba River alone there were stored more than one hundred and forty million cubic yards of accumulations, and the bed of the river had spread over a width of two and one-half miles between the side levees built to confine the spread of the deposits. Upon the other hand, of the estimated yield of about $614,000,000 of gold mined in California between 1858 and 1881, a very large share had been extracted by hydraulic mining.

In consequence of the damage caused by the industry, suits followed to enjoin the mines. During 1880–1881, dams were constructed under direction of the State government to store detritus in the Yuba and Bear Rivers, but the work being only partially effectual, was soon discontinued. Years of litigation ensued, alternated with efforts to secure the aid of the Federal Government through its interest in preserving navigation on the rivers. The industry gradually waned in importance, owing to the legal obstacles placed in the way of working the mines and partly owing



MOORE'S FLAT DAM, BUILT OF LOGS AND BOARDS.



LOWER SLATE CREEK DAM, FROM BELOW.

IMPOUNDING BASIN, GOPHER HILL MINE, PLUMAS COUNTY, CAL.

HYDRAULIC MINING IN CALIFORNIA.

to lack of inducement for capital to seek investment in new enterprises or to adequately keep up the works in use. The output from the hydraulic mines in 1892 was perhaps less than ten per cent. of the estimated output ten years earlier.

Finally an act was passed by Congress and approve March 1, 1893, known as the Caminetti Act. This act provided for the appointment of a commission to consist of three officers of the Corps of Engineers, United States Army. It made unauthorized hydraulic mining punishable by fine and imprisonment, and the duties of the Commission, briefly stated, are: "First, the prevention of such hydraulic mining as may be deemed injurious to the navigable waters within the Commission's jurisdiction, permitting, under proper regulation, such mining in cases where it can be carried on without such injury; second, to mature general plans for the improvement of the rivers whose navigability has been injured by hydraulic mining, and, if practicable, to devise general methods whereby such mining may be carried on without damage to the navigable waters."

The present members of the Commission are Colonel S. M. Mansfield, President; Lieut. Col. W. H. Heuer and Captain Herbert Deakyne, Secretary, all members of the Corps of Engineers, United States Army.

The Caminetti Act has been in force since 1893, and under its provisions 468 mines have applied for authority to operate and 360 mines have been granted permits to use the hydraulic process, but not all of these are in operation. Many of the licensed mines are small ones, the large proportion of which is explainable owing to the relatively greater ease with which storage sites are procurable for the small mines and also the smaller outlay required to equip them. The exceptionally severe winter of 1891 and 1892, and the effect of the very deep snow, caused the wrecking of miles of flumes and seriously impaired the efficiency of almost every water supply belonging to the large mines, all of which draw their water from sources located at high altitudes in the Sierras. The uncertain status of hydraulic mining and the large outlay necessary to repair these water supplies has contributed in a large measure to their disuse or only partial repair, and, in fact, did more to check hydraulic mining than litigation or any other cause. The smaller mines were not affected in like degree.

The reports of the California Débris Commission show an estimate of 5,722,783 cubic yards of material moved by licensed mines between October, 1893, and July 1, 1899. The largest hydraulic mine, the North Bloomfield, has never been under control of the Commission, and its product is not included in the above estimate. It has impounding works, where débris is stored, and its output of gravel is believed to have approximated one million yards per annum since the impounding of its detritus began. In the years when the mine operated without any restriction, its output was undoubtedly much in excess of this figure.

The material impounded has been stored by dams built across the beds of streams, and in many cases by causing its deposit upon flat areas adjacent to the streams and in the worked-out pits of abandoned mines. The latter localities have always been preferred by the Commission, as the deposited material is permanently arrested in them, whereas material stored in the streams is subject to being partly removed should a dam break or rot away. In no instance has a dam been authorized in any stream draining a large watershed, and wherever practicable they have been supplemented by wasteways cut in rock to carry flood water around the dams instead of over them.

The relatively small values contained in hydraulic mining gravel make it necessary, for profitable working, that the cost of storage shall not be large. For this reason the dams, so far as yet built, are inexpensive structures, and are planned to utilize material handy to the work, principally brush, logs and rock.

For use in water courses there are two principal types of work, brushwork and log cribbing. The brushwork consists of brush usually about 8 or 10 feet long, placed in layers with the butts even and down stream, each layer separated by large poles or small logs laid lengthwise with the dam about 1½ feet from the butts of the brush. All the large limbs are lopped off so that the brush will lie compactly, and the dam is so built that when completed the butts are about two feet higher than the tops, so that the latter are well imbedded in the mud before the dam is full. Work of this character is substantial and lasting, and when properly weighted and bound with wires will allow a large flow of water to pass over it without damage. It derives its support principally from the weight of the material lodged above the brush and in its interstices, the poles, which vary from 5 to 12 inches in diameter, serving mainly as spreaders to make up the difference between the thickness of the butts and that of the bushy ends of the brush, thus preserving the proper inclination of the latter to make regular work. The principal limitation to the use of this character of work is the fact that no considerable height can be laid up at one time without making it springy and deficient in compactness. Usually 5 or 6 feet of work is laid first and mine material allowed to accumulate till it covers the tops of the top layer of brush, and the dam is afterward added to, layer by layer, as accumulations collect in the basin, keeping the crest always about the same height above the level of the mud. When used in water courses the total height for this kind of work is ordinarily not permitted to exceed 20 feet in one structure.

The log crib structures consist of an up-stream and a down-stream wall of logs, varying from 14 inches to 3 feet or more in thickness, usually not less than 15 feet apart, connected by cross logs, the walls of the cross logs being spaced more than 16 feet apart, all logs being well notched at crossings and drift-bolted at each crossing. The lower course is usually bolted strongly to bed rock. The up-stream wall is vertical and the down-stream wall is given a slight slant up-stream, and the end logs of both walls are firmly joined into the sides of the creek. The cross logs are inclined slightly so that their down-stream ends are 2 to 3 feet higher than the up-stream ends. The log framework of such dams is commonly given a height of 12 to 20 feet and inspected before mining is allowed to begin. Their lower parts are filled with rock and gravel to weigh them, the height of filling prescribed varying with the degree of flood exposure and according to the total height to be finally given the structure. About 40 feet is commonly fixed as a limit of height for such dams, but plans for dams 60 and even 80 feet in height have been approved, the base being then correspondingly increased to 24 or 30 feet, and a complete filling with rock is made a requirement.

There are numerous combinations and modifications of these two styles of work in use.

An interesting type of débris dam consists of an up-stream face and a down-stream face of sloping brush work, gravel or broken rock being sluiced in as a filling between the brush walls to form the body of the dam. The base is made sufficiently wide to permit the walls to be drawn in upon slopes of 45° or steeper, allowing for a crest width of about 14 feet on top. During construction the work is protected by a shaft built with large, well-framed log sides communicating with a tunnel in bed rock, which passes under the dam, the sectional dimensions being sufficiently large to carry any flood likely to occur, thus providing that floods shall pass out under the dam and not pass over it. The shaft is built up gradually, and its top kept several feet below the level of the work on the dam, and detritus from the mine is allowed to collect in the basin. When the dam is finished a waste-way is cut past one abutment, the tunnel is blocked at its lower end, and it and the shaft then sealed tight with gravel, after which all water passes out by the waste channel. A dam of this character, over 90 feet high, has been built, and constitutes a substantial and a cheap structure, the gravel filling of the dam being selected material removed from the mine during its regular operation. The gravel was delivered on the dam in a sluice, the principal cost being that for distributing it over the surface of the dam, but which required only the labor of about three men to direct the gravel from point to point as desired.

Where the storage site is in a worked-out mining pit or upon natural level land, not subject to serious flooding during storms, light embankments of gravel or brushwork are thrown up where necessary, to close in the flat or pit and form a basin in which sediment is allowed to collect to within a few feet of the level of the top of the barriers, the height of the latter being added to, a few inches at a time, in order to keep the top about a uniform distance above the increasing level of the surface of the sediment. The water from the reservoir is passed off through a shaft and tunnel, if convenient to do so, or through a timber and plank discharge flume, or weir, across the opening of which planks are gradually inserted so as to raise the level of the escape and keep it above the mud. As no water is permitted to pass over the barriers, and their tops are kept only a few feet above the impounded detritus, the amount of material to build the barriers is much reduced, and their cost is very small.

The object of all these works is to produce a pool of dead water above the dam several feet deep and of sufficient area to form a settling basin in which sand and silt and a large part of the earthy matter will deposit, permitting only discolored water to escape from the reservoirs.

The cost of the dam structures is reduced by taking advantage of the fact that they are to stop solid matter and to hold back only a small depth of water, and the cost of impounding is further reduced by providing still less costly barriers above the principal works, the auxiliary barriers not being kept water-tight, but acting merely as strainers or arresters for cobbles and gravel, which are thus kept from entering and occupying space in the more expensive settling reservoirs. Thus a large percentage of the total bulk is stored at almost nominal cost.

Under the Caminetti Act hydraulic mining has been resumed only very partially; partly owing to reasons already stated. The Act has, however, enabled a great many small mines to operate without fear of legal interference, and it has, moreover, been beneficial to all hydraulic mining interests, inasmuch as it has removed an indiscriminating interdiction of the industry and provided in place thereof an expert body entrusted with judicial powers to determine under what special conditions given mines may operate without causing damage. It has thereby restored to hydraulic mining property negotiable value.

In the second line of its duty the California Débris Commission has since 1897 been conducting investigations and making studies as to the best manner of preventing removal into the navigable rivers of the large accumulations of detritus now in the bed of the Yuba River, and of rectifying and confining the channel of that stream. For this purpose appropriations amounting to $500,000 are available, of which sum one-half has been provided by the State of California and an equal amount by the Federal Government.

A plan of treatment has been adopted by the Commission and recommended by the Chief of Engineers, and is now before Congress for final approval.

The report of the Commission has not yet been made public, but will probably be printed in the annual report of the Débris Commission. The purpose of the project is to protect navigation and stop detritus already lodged in the tributaries of the Sacramento River, but the methods and treatment proposed for this purpose, if found effectual in practical working, may show themselves capable of enlargement and extension so as to provide for storage of hydraulic gravel deposits not yet mined, which is also an object contemplated in the Caminetti Act. There is, therefore, the prospect of a resumption of hydraulic mining upon a more extended scale.

The practical results following the creation of the Débris Commission in California have been appreciable from its creation in 1894. Each year has added to the gold production of the State in the regions where formerly placer mining was extinguished, that is, in the valleys of the Sacramento and San Joaquin Rivers, though only for the years 1897 and 1898 has the amount of the increase been segregated. The result for the year 1899 has not yet been announced by the statistician of the Mint, but is expected to show a production of $500,000 from débris mining alone. It is to be remembered also that these years have been phenomenal in respect to the small amount of rainfall, being only about one-half the average precipitation.

In 1897 the product of gold resulting from the construction of dams was $393,610; in 1898 $371,881. An approximate estimate for the seven years since 1894 would probably give over $2,700,000 as the total saved by means of the débris dams.

The correspondent of the SCIENTIFIC AMERICAN is indebted to Mr. Herbert Vischer, Engineer of the California Débris Commission, for much valuable information and assistance. Our engravings are from photographs and show the Impounding Basin, Gopher Hill Mine, Spanish Ranch, Plumas Co., Cal. Moore's Flat Dam in Moore's Flat Creek is made of two lines of logs 24 feet apart, keyed together by cross logs; openings between the logs vary from 9 inches to 2 feet; the lower line of logs is lined with thin boards, leaving openings all along of 1 inch to 9 inches square. The cribs are filled by the débris only; they are 36 feet high, 150 long on top, and rest on brush in the channel of the creek. The watershed is 3 miles square.

## FARMING BY MACHINERY.

LABORIOUS toil for the cultivator of the land is rapidly becoming a thing of the past. The term "horny-handed tiller of the soil" within a few years will be relegated in the United States to the vernacular of the poet, says a writer in the New York Sun. Automatic labor-saving machinery is supplanting the necessity for bodily labor in all agricultural processes from the turning of the sod to the harvesting of the crop. What little manual labor is required is devoted to supervision of the working parts of the various machines employed.

In 1800 not a single cast-iron plow was in use. The plow was home-made, of wood covered with sheet iron. The man with the hoe was the laborious cultivator. There were no mowers, reapers, or self-binders driven by horse power. Grain was scattered by hand and harvested with the sickle or the scythe. It was threshed on the barn floor and ground into flour full of impurities, in rude grist mills, driven by great over-shot water wheels. In 1900 the plowman uses a sulky plow upon which he has a comfortable seat from which to guide a pair of horses. The machine does the rest. The reversible sulky plow is equally adapted to stony, rough, side-hill work or level ground. In the former case it turns the sod with the slope, in the latter it leaves the land without tracks or dead furrows. For this work a right and left hand steel plow is mounted upon a steel beam, one being at right angles with the other, and easily revolved by unlocking a hand lever at the rear of the driver, the weight of the upper plow causing the lower to rise. Each plow has an easy adjustment to make it cut a wide or narrow furrow, and is raised out of the ground by a power lift and set in again by a foot lever, so that the operator has both hands with which to manage his team. An adjustable seat enables the driver to sit always in a level position and on the uppermost side in plowing side-hill land. In a few years horse labor will be dispensed with for moving this machine and some auto-power substituted. It may be if electricity is employed that the farmer will be able to sit smoking his pipe on his porch with a switchboard before him and control many plows. With electric motors applied to all agricultural implements a single man may be able to plow, harrow, fertilize, sow, and harvest his crops with no expenditure whatever of bodily labor or one cent of cost for the hire of human hands.

In earlier days the harrow was a crude home-made square or triangular machine, on which wooden, and later, iron pegs were inserted. In some cases a log drawn to and fro was employed to level the furrows. In these times farmers use sulky-harrows of every imaginable form and device according to the local condition. There is a pulverizing harrow, clod crusher and leveller combined in one machine. This crushes, cuts, lifts, turns, smooths and levels the soil all in one operation. It also prepares a perfect seed bed and covers the seed in the best manner. The operator from his seat on the machine effects all of these processes by turning a lever. Then there is a ball-bearing disk harrower with dirt-proof oil chambers. This machine does everything but supply the driver, automatically, with a glass of beer.

There is no more laborious kind of farm work than the spreading of manure; so much so that in farming on a large scale it is difficult to procure labor for the purpose. This can now be dispensed with. A machine called the manure spreader does all this work. It is drawn by horses and operated by one man. It breaks up and makes fine all kinds of manure and spreads it evenly upon the land in any desired quantity. It will spread very coarse manure, cornstalks or wood ashes, or guano—in fact, any manure or fertilizer, fine or coarse. Provided with a drill attachment it distributes compost direct in the drill before the seed is sown. It does everything in the manuring way except to use foul language.

When it comes to the planting of crops there is a machine for every process from the sowing of cereals, seeds, and tubers, to the setting out of plants. For grain or grass there is a driving broadcast seeder, which is attached to an ordinary wagon. It also distributes all kinds of dry commercial fertilizers. It allows of the sowing of seed of any size. Then there is a grain drill driven by horse power, in which the quantity to be sown is easily regulated by a lever. It is also provided with a land measure or clock, which is adjusted before beginning the day's work. It is fitted with hoes which can be instantly changed by a lever, even while the machine is in motion, to run either straight or zigzag. For grass seeding the hoes can be adjusted to distribute the seed in front or behind them. There is also a fertilizer distributing attachment. There is still another grain seeder which weeds as well as sows. The riding corn and bean planter is a remarkable machine. It opens the soil, drops seed, covers and marks the next row at one operation. It drops corn in hills from 9 to 48 inches apart, or for ensilage or fodder in a continuous drill. It drops alternately, if desired, a hill of corn and a hill of beans from 9 to 48 inches apart. It also distributes fertilizer in a continuous drill at the same time the seed is dropped and both are covered by the single operation at any desired depth.

For the planting of tubers like the potato there is primarily a machine that divides this root into halves, quarters, or any number of parts, separates the eyes and removes the seed ends. It does the work of ten men. When it comes to the planting there is employed an automatic machine drawn by two horses, the driver occupying a seat at its front. It plants whole or cut potatoes at any distance apart desired. It drops the seed, covers it with moist under-earth, and marks for

the next row all at one operation. It also sows fertilizer, placing it just below the seed, after sufficient earth has been mixed with the former. It is provided with steel runners or disks to cover the seed, and these yield to all irregularities of the soil. For the transplanting of plants, such as tomatoes, cauliflower, cabbages, celery, in fact, all plants that do not require to be set nearer than one foot apart, the automatic plant setting machine will cover from four to six acres a day. An automatic check valve fitted to a tank attached to the machine lets water flow through a hose extending in behind the shoe or furrower, just before setting the plant. The flow can be regulated from one to six barrels an acre.

Formerly, when crops were planted and had begun to grow, farmers and vegetable gardeners had to ply the hoe vigorously in order to loosen or cultivate the soil and to keep down weeds. This was hard work, and, moreover, where growth was rapid and rank, it involved hiring extra labor. The talent of inventors has reduced the fatigue of this agricultural function to a minimum. Most of these machines are light and operated by man power. There are others in which horses are used. Those who employ call them the greatest labor-savers of the age. There are some provided with a number of spring steel teeth, which, while they do not injure the plants, loosen and uproot the weeds. These are more on the principle of the harrow. There is a machine for cultivating and hilling celery. It is through the use of these devices that celery is marketed in such perfect condition, with every stalk bleached to its very top. Potatoes are cultivated and hilled up by a special machine that does the work of many men far more thoroughly and expeditiously than human hands can accomplish it. There are many machines combining hoe, cultivator, rake, and plow; the latest machine plows, furrows, covers, and hills; there are rakes for shallow cultivation, fining, leveling, and pulverizing the soil; there are cultivator teeth for deep stirring of the soil, and flat hoes of different widths for loosening crust and cutting off weeds.

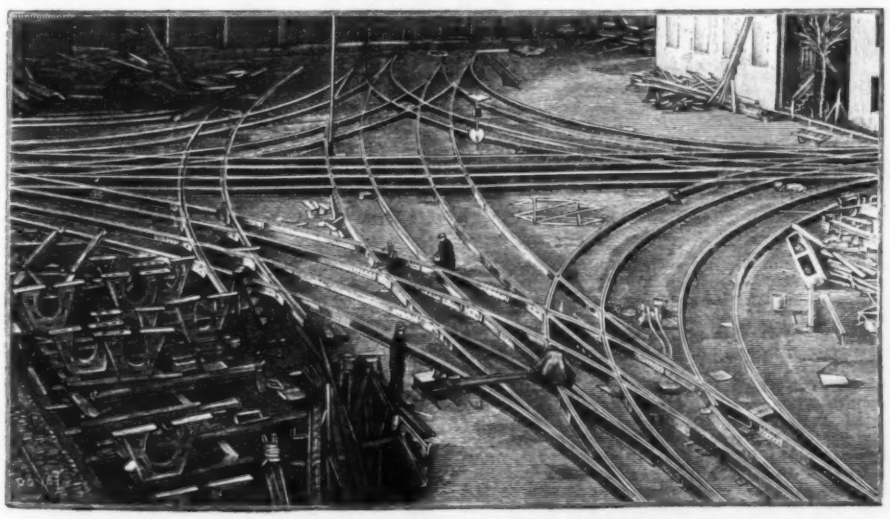
Every growing plant except cotton is now provided with a cultivator that does away with an immense expenditure of human toil. As yet no machine has been perfected that picks cotton with the discrimination of man. The difficulty to be overcome is to avoid injury to mature cotton balls that are growing on the same plant with those that are immature. No doubt some method will be found that will overcome this defect. Then the Southern darky will find his services no longer so eagerly sought for as they are at present.

Machines to harvest crops come in every variety to perform a special function. Everyone is familiar with the mowing machine. It has driven the scythe out of use. Formerly there were men whose trade was confined exclusively to the use of this implement. None is following it to-day. The same is true of reapers and binders of grain; a single machine will do the work of twenty or more men. The old-fashioned flail to thresh grain is now a curiosity. The rattle of the power-thresher is a familiar sound in autumn to every resident of a farming country. The sulky hay-tender will thoroughly turn and spread four acres of cut grass in an hour. This can be repeated so often that in a single day the crop of hay from that amount of land can be cured and stored. In loading the crop, human hands are no longer necessary, except to guide the team that draws the wagon. The machine hay loader will put on a load in five minutes. It takes the hay direct from the swath, though it will rake and load from light windrows.

There is a labor-saving machine for every agricultural process, most of them automatic. Farming in the future will not be synonymous with toil. What heretofore the farmer has expended in the hire of labor he will devote to the purchase of machinery. This does not consume food, neither does it sulk and throw up a job at the most inopportune moment, nor strike for higher pay. The farmer of the future will be more or less a man of leisure. The machine will do the work. The weather, however, as in the past, will suffice to make him a man with a grievance.

## A REMARKABLE RAILWAY CROSSING.

THE accompanying engraving, reproduced from The Street Railway Journal, represents a railway crossing



A RAILWAY CROSSING AT BOSTON.

recently arranged at Dewey Square, Boston, in front of the terminal station of the railways of that city.

The question was to allow two street railway tracks to cross two railway lines, properly so called, that form a curve at this point, and also a third railway that is normally devoted to freight traffic. But, as shown in the figure, it was also a question of connecting the four tracks first mentioned by means of two sets of curves (and consequently by switches) deviating from each side of the axis of the tracks that are seen running from right to left in the figure. In consequence of the curve of the two other tracks, the arrangements were in nowise symmetrical; and, finally, the freight track had to intersect six street railway tracks, or, in other words, twelve rails.

It will be readily seen that the arranging of these tracks according to an obliquity that is variable for each of them involved great difficulties, both in the way of planning and execution. In fact, in this work there are no less than 183 points of intersection. At the crossing points in question there were arranged pieces of manganese steel, in order to obtain a greater resistance. The tracks of the railway lines, of course, are formed of rails and counter rails, having the same height as the grooved rails of the street railway tracks.

In this complicated crossing 170 tons of metal were employed; but this did not prevent the work from being successfully completed with extraordinary rapidity, the studies and the execution having required, in all, but six weeks at the works of William Wharton & Co., of Philadelphia. The mounting was completely effected in these works before delivery; and the tracks were shipped upon seven cars and laid in three days. This important crossing cost no less than $15,000.

## THE THICKNESS OF MACADAM MATERIAL.

A LARGE percentage of bad macadam roads owe their poor quality to the fact that they are not built with sufficient thickness, and this point is admirably emphasized by the series of diagrams which we present and which form part of the report on the highways of Maryland, prepared under the direction of Prof. W. Bullock Clark, State Geologist. The section to which we refer was written by Arthur Newhall Johnson, who says it was formerly the custom to build roads with what is now considered an excessive thickness of stone. The famous Roman roads, to which allusion is made so frequently, were over three feet thick, the lower course consisting of large stones with smaller ones in the upper course, between which there was a layer of concrete, and over all was laid a stone pavement composed of large, flat stones, finely joined. Most of the turnpikes of Maryland were built at least 18 inches thick, with the lower course of large stones 10 to 12 inches in diameter, the top course being of smaller broken rock. If it is possible to lessen the thickness of the stone covering, it is evident that the construction would be proportionately cheaper. The determination of the thickness required is, therefore, a very important consideration.

Those roads where the telford construction has been employed, that is, where the lower course consists of large stones from 8 to 12 inches in size, have no more wearing strength than a road with a thinner stone covering, for as soon as they are worn down to the largest stones, the surface becomes rough and uneven, and required resurfacing.

It is well to keep in mind the object of the surface material, which is to afford protection to the foundation,

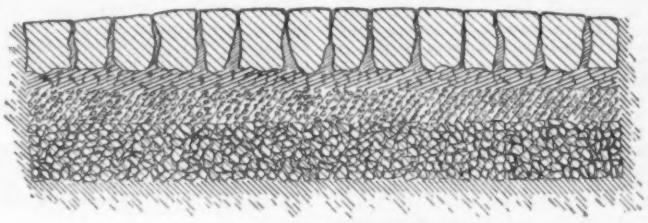


FIG. 1.—ROMAN ROAD.

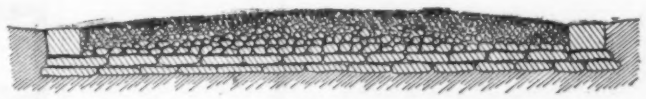


FIG. 2.—EARLY EIGHTEENTH CENTURY ROAD.

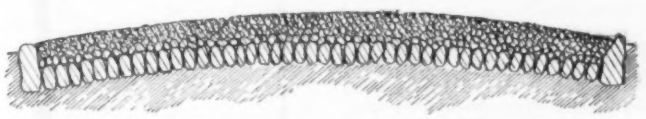


FIG. 3.—LATE EIGHTEENTH CENTURY ROAD.

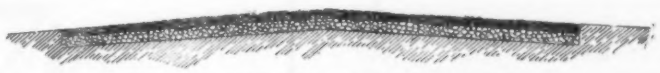


FIG. 4.—MODERN MACADAM ROAD.

so that it may not be softened by the rain or cut up by traffic. It must, therefore, be of such a nature as to resist the wear of the different kinds of traffic to which it may be subjected; but it should not be depended upon to hold up the entire load. This part of the work is done by the foundation, and when surfacing material is applied to a roadbed, it should be in such condition as to support a loaded wagon. Dry, consolidated earth will do this, and if it can be kept in this condition no trouble will arise.

The actual pressure which the earth immediately below the macadam has to carry is less than is actually borne by the surface of the road, as the effect of the layer of compacted stone is to distribute the pressure over a greater area. In other words, the layer of macadam reduces the weight per square inch which the foundation is obliged to carry. The pressure will be practically the same with a very thin layer, while with a thicker one it may be conceived that the weight rests upon the top of a pyramid which it distributes to the foundation over the larger area of its base. If the earth foundation alone will carry the weight of loaded wagons, any thickness of stone more than assures this; thus, such a thickness of covering only is required as will insure the formation of a compacted mass which will not be loosened by the travel over it.

When a thickness of metal has been put upon the roadbed sufficient to resist the pressure from traffic, manifestly the condition of the surface will not depend upon their being an extra thickness. Thus, if there is a road with 12 inches of material and another with 6 inches, the 6 inches being sufficient to support the travel, the 12-inch road is no better than the 6-inch. It is merely so much money buried into the shape of broken stone. It is only the 2 or 3 inches of the top which receive the wear, for when these two or three inches are worn away, it is necessary to resurface, as the road has become more or less uneven, owing to the fact that the wear is seldom equal over all portions of the roadway. The macadam road rolled to a thickness of 6 inches has been found everywhere to be all-sufficient. With the foundation well drained, there are few places which require the telford construction. On a firm, dry soil, roads have been built with a covering of rock which compacts well, not exceeding 4 inches in thickness, over which there has been a great amount of travel, and they have proved satisfactory in every way.

Our engravings, 1 to 4, show the proportionate thickness of the old and modern roads. In addition to their varied thickness will be noticed the difference in the form of the foundations, which are now shaped to conform to that of the finished surface. This important change was introduced by the French engineer Trésaguet about the middle of the last century.

## RUNNING A BLAST FURNACE.

FEW people who have not actually run a blast furnace realize what it means. According to The Engineering Magazine, a stack of 200 tons daily capacity, running on 50 per cent. ore, must have delivered to it each day something more than 400 tons of ore, 250 tons to 300 tons of coke, and over 100 tons of limestone, besides sand, coal, and minor supplies—say 900 tons of raw materials. Add the 200 tons of pig iron product shipped out, and we have a daily freight movement of 1,100 tons, taking no note of the disposition of the slag. The mining of the ore requires the labor of 150 to 300 men; the coal mining, coke making, quarrying of limestone and transportation, at least 300 more. The furnace itself employs about 150 or more hands. Starting up a furnace of ordinary capacity, therefore, calls immediately for the labor of nearly a thousand men; for the use of at least a thousand railway cars

and many locomotives, for perhaps several steamers and vessels; for capital, from the mines to the pig iron, of one to two millions of dollars, and last, but not least, for a high order of managing ability.

## MACHINES FOR RAISING WATER.

IN Fig. 1, the buckets, *A*, which are to carry water from the reservoir, *B*, to the reservoir, *C*, are united in a string by a double chain whose two parts, which are long and equal, are formed of jointed links and are connected at equal distances by plates of iron.

The buckets are attached to these plates by loose and very short pins, in order that they may turn when they reach the edge of the reservoir, *C*, where they meet with the catch, *D*, which causes them to tilt in order to empty their water. The lower extremity of the chain enters the reservior, *B*, to a sufficient depth to allow the buckets to fill. The chain is suspended from the drum, *E*, and, in measure as the latter revolves, the buckets pass one after the other over the upper circumference and thereby empty their water into the reservoir, *C*.

As regards the drum, *E*, it will be readily seen that this is set in motion through the face wheel and trundle, *F* and *G*, corresponding to the face wheel and trundle, *H* and *I*, which are actuated by the large wheel, *K*, that the current of the river causes to revolve.

In Fig. 2 we show a modified form of device for raising water consisting of an enormous tread-mill designed to be rotated by an ox or horse, a series of buckets are mounted upon the periphery of the wheel and these filled in the tank beneath. When the bucket reaches the highest point of elevation it is tilted automatically and the water is poured into a reservoir above.—From Recueil d'Ouvrages Curieux de Mathematique et de Mechanique, 1733.

## GELATIN AS APPLIED TO THE MANUFACTURE OF ARTIFICIAL SILK.

By CHARLES E. MILLER.

THE beauty of the materials produced from silk together with its high price, have induced several persons to try to obtain similar effects at a reduced cost. The result has been that several patents have been taken out for producing so-called artificial silk, or for giving a lustrous appearance principally to cotton and linen.

Dr. Lehner and Count Hilaire de Chardonnet have patented processes, which differ only in certain details of working, for producing a thread from cellulose by converting it into collodion. Mr. C. F. Cross has another method of producing a thread also from cellulose, but by using thio-carbonate of cellulose. Solutions of cellulose in zinc chloride and also in an ammoniacal solution of cupric oxide have also been proposed for producing lustrous threads.

Cotton yarns with a silky appearance have come prominently before the notice of manufacturers under the name of mercerized cotton, so called after the inventor of the process, John Mercer. The process of mercerization, which consists in treating cotton yarn with strong caustic soda solution, was originally patented for the purpose of increasing the affinity of cotton for coloring matters, and not for the production of luster. Other silk substitutes are put on the market under the names of polished cotton, beat linen, silkette, etc.

None of the foregoing materials have any claim to the name of artificial silk, as they are in no way related to silk and would be much more appropriately termed "lustro cellulose," as proposed by Mr. C. F. Cross.

Vanduara silk, the invention of the late Mr. Adam Millar, is the only artificial product so far which has any claim to the name of "artificial silk," because it is of animal origin, while the others are vegetable, and in its chemical reactions has many points in common with the real material. The process for producing vanduara silk was described in detail by the late Mr. Millar, in the paper which he read before this Society on December 19, 1898, entitled "On the Manufacture of Artificial Silk from Gelatin, and a Method for ascertaining the relative Merits of Different Samples of Gelatin for that Manufacture," which paper was published in this journal, January 31, 1899. It is to this product and especially to the material used for its manufacture that I wish to call your attention to-night.

The process of manufacture is briefly this. A thick solution of gelatin, about 62 per cent. of dry gelatin, and 38 per cent. of water is made, and the necessary color added to produce whatever shade is desired. When the solution has become perfectly homogeneous it is poured into jacketed cylinders capable of holding sufficient solution for a day's production of yarn. The cylinders are provided with a filter through which the gelatin solution is forced by air pressure into a small box, also connected to the cylinder, and which is fitted with as many nipples as there are to be filaments in the thread. Both cylinder and nipple box are kept warm by a hot water circulation.

The fine streams of gelatin coming from the nipples are received on an endless travelling band, where they are dried, and from which they are wound on to bobbins. The filaments are still soluble in water, and for the purpose of rendering them insoluble they are wound on reels and exposed to the action of moist formaline vapor. The yarn is exposed to the action of the vapor for about 24 hours, when it is taken out and exposed to dry air for 12 or 14 hours to free it from the smell of the formaline, and also to dry it. The silk is then ready for twisting and winding by the usual methods.

Having thus briefly described the method of producing vanduara silk, I will now deal first with the qualities or properties required by gelatin used for this purpose, and, secondly, with the chemical problems which require attention in the production of this artificial silk.

A very important quality of gelatin is that of regularity of composition. Up till now glue and gelatin have been used principally as adhesives for making joints, for confectionery and culinary purposes, also for making films or veneers for photographic and decorative uses, and for sizing or stiffening in various trades. Now for all these purposes, although it is certainly an advantage to have a glue or gelatin of regular composition, still a little variation is not a serious matter. In the manufacture of artificial silk, on the other hand, a slight variation in the gelatin gives considerable trouble for the following reasons.

When describing the method of making up the gelatin solution, I gave the proportions as 62 per cent. of dry gelatin and 38 per cent. of water, but, although this is about the average composition of the solution, it has to be varied one way or another so as to produce a jelly of regular viscosity. If the proportion of gelatin to water was a fixed quantity we would have a solution thicker at one time than another, with the result that the thread produced would not be regular, that is to say, the filaments would vary in diameter, and of course it is of the utmost importance that there should be no such variation. You will therefore see that it is not quite correct to say that a certain percentage of dry gelatin is used, as under the present method of gelatin manufacture we would have solutions of varying viscosity, whereas if a standard material could be produced, the same percentage composition would give a jelly of standard viscosity.

Other means than varying the composition of the solution can of course be used for correcting the variation in viscosity of the jelly, such as increasing or diminishing the temperature and pressure at the drawing frames. This, however, is not a good method of working, as it is found more satisfactory to keep the machines working at constant speed, pressure and temperature, and rather alter the composition of the solution.

The drawing frame for producing the filaments is really a species of viscometer. The gelatin solution being put into the cylinders is forced through the nipples at a constant temperature (130° F.), constant pressure 10 pounds per square inch, and drawn at a constant speed 70 yards per minute. If the amount of yarn produced in a given time, or, what is the same thing, if a standard length be taken, say 840 yards equal to 1 hank, and also equal to 12 minutes' running and the weight taken, you will see that this is the same principle as other viscometers. I may say that we have found some deliveries of what is supposed to be the same quality of gelatin were of absolutely no use for the production of artificial silk.

As a quick method of testing the viscosity of a gelatin solution, I have found the method proposed by Lippowitz give fairly satisfactory results. This method consists in making 10 per cent. or 15 per cent. solutions of the gelatins to be tested, and also of a standard gelatin with which to compare the others. When the gelatin solutions have become perfectly homogeneous, they are each poured into separate jars, which should all be as nearly the same size as possible, and laid aside for 12-24 hours to let them set.

The apparatus for testing the jellies is very simple, consisting of a light spindle which works freely up and down in a bearing. To one end of the spindle is soldered a small perforated metal disk, and to the other end is fixed a pan for holding weights. The spindle may be graduated if desired. The perforated disk is placed on the top of the jelly to be tested, and weights are placed on the pan till the disk breaks the jelly, or till it is forced down to a certain point shown by the graduated spindle. The greater the consistency of the jelly or viscosity of the solution, the heavier the weight will be required to force the disk into the jelly. By this method the quantity of water required to produce the viscosity of the standard gelatin solution can be fairly accurately found. It would certainly be a great benefit if some means of testing the viscosity of solutions could be devised similar to testing the specific gravity by hydrometers.

Another important feature is the color of gelatin. Those which possess a dark color are only suitable for producing yarn which is to be dyed black or deep shades, and cannot be used for producing white or pale shades. In producing a gelatin suitable for these, it is important that a process for bleaching should be used that will in no way injure the strength or tenacity of the material. It would also be beneficial if the gelatin were not quite transparent, but rather semi-opaque. Gelatin for the production of artificial silk must be tough and not brittle. Some gelatins of otherwise good qualities are rendered useless for thread-making on account of their extreme brittleness. A fairly good method of testing the brittleness is to make films from 15 per cent. to 20 per cent. solutions of the gelatins to be tested. If it is a fairly tough gelatin, strips 8 or 9 inches long cut from the dry films should stand bending till the ends meet, forming a circle without breaking. Some gelatins can hardly be made into films without flying into splinters while drying.

Cohesion is another important quality. As a rule the power of adhesion is the quality required, but this is rather a drawback than a benefit in the manufacture of artificial silk, as it would tend to stick to the band used for drying the filaments which would cause trouble in winding. The quality of cohesion is wanted, so that when the thick solution is forced through the nipples, it may be drawn out without breaking. Some gelatins possess no tenacity or cohesion and cannot be

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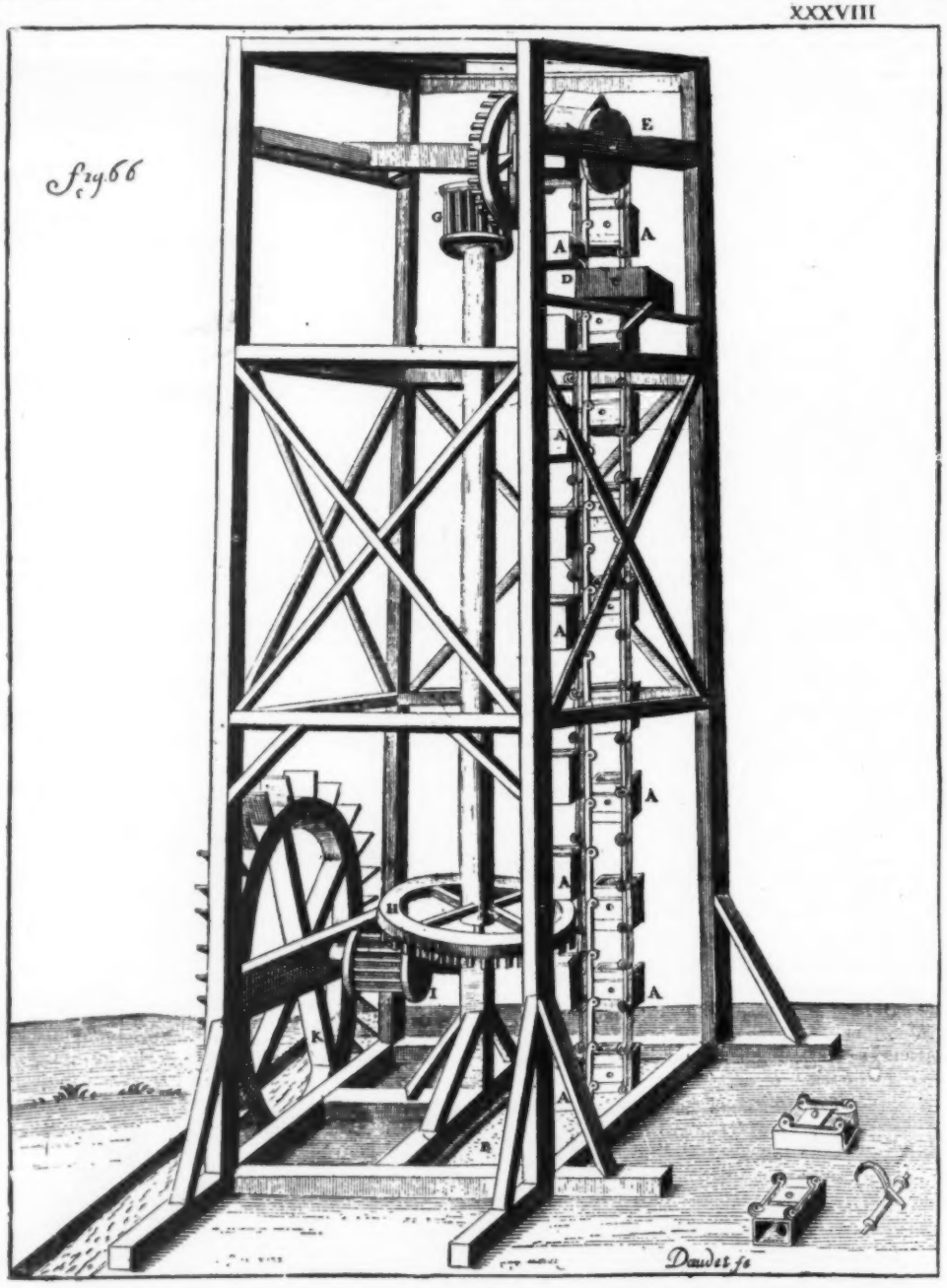


FIG. 1.—MACHINE FOR RAISING WATER.

drawn into a thread, as the filaments simply break off short as soon as they leave the nipples.

Gelatin makers unfortunately seem to have got into a rut, and have directed their attention principally to the means of getting the greatest output from a given quantity of raw material at the lowest cost. They have done little or nothing to find out what glue really is, or, in other words, to determine its constitution. It is no doubt a very difficult task to do this, but that is no reason why it should not at least be attempted, and certainly no great progress can be made till this is done. It seems to me more than likely that in treating hides or bones for the production of glue or gelatin by the existing methods, more is extracted than is really wanted, but till this branch of manufacture is put on a more scientific basis, it is impossible to tell what is wanted and what is not.

It is well known that real silk consists of two distinct parts. There is the central portion, which is really the fibre and termed fibroin, and round this central portion there is a coating or envelope of gum which is known as sericin. Although many chemists have studied silk, we are still in ignorance of its chemical structure, but progress is certainly being made in this direction. There has been a certain relation traced by some between fibroin and sericin. The formula given for fibroin is $C_{15}H_{23}N_5O_6$, while that of sericin is $C_{15}H_{25}N_5O_8$, which shows that sericin has 2 atoms more H and 2 atoms more O than fibroin. Some chemists hold the view that at the moment of secretion silk consists entirely of fibroin, which, by the action of air and moisture, is altered superficially into this silk gum or glue known as sericin. Now this sericin is very similar to ordinary gelatin in many respects, being soluble in hot water and forming a jelly on cooling. It is precipitated from its solution by tannic acid, alcohol, potassium ferro-cyanide, basic lead acetate and several other metallic salts. Ordinary gelatin is precipitated from its solution by tannic acid and alcohol, but not by the metallic salts. Sericin yields different products than ordinary gelatin when boiled with dilute acids. Now with gelatin being so similar to sericin, and this again differing from fibroin by the addition of 2 (OH) groups, it looks as if there were a close and interesting relation existing between these substances.

In manufacturing vanduara silk, we have surmounted all the difficulties of producing what is practically a perfect artificial silk with two exceptions. When we first started manufacturing, we had a good number of troubles to overcome, not least among which was the means of being able to work the process under all variations of the atmosphere.

When drawing the filaments, I have already mentioned that they are received on an endless traveling band, for the purpose of drying. Now from the time that the filaments leave the nipples, when they contain 38 per cent. of moisture, till the time they are wound on the bobbin, they have only 55 seconds to dry. Heat will not necessarily dry them, although one is surprised at the number of people who think it will. What we have to do is to produce a dry atmosphere, and this we have done by fitting up an appliance by which we can either dry the air or damp it.

Another difficulty was to produce a thread free from air-bells, which very materially affected the tensile strength, and also to obtain a thread which would be regular in grist. In fact, no sooner had we overcome one difficulty than another presented itself; but I am glad to say we have got over them all with, as I have already said, two exceptions. The first of these is to obtain a good white which will be slightly opaque; and secondly, to prevent the thread losing its strength when wet or exposed to a damp atmosphere.

The first of these difficulties presents an interesting problem for gelatin-makers. The clearest gelatin which we have yet obtained produces a creamy white, and when viewed in bulk it is rather silvery looking. This defect, of course, is due to the gelatin not being perfectly bleached, and also to its being too transparent.

The second difficulty opens a good field for research to all chemists. What is wanted is either to reduce the hygroscopic nature of the thread, or, at least, to treat it so that its tensile strength is not diminished when wet. Even real silk is very hygroscopic, being capable of absorbing as much as 30 per cent. of its weight of moisture without this being at all perceptible, but its tensile strength is not reduced to any great extent.

In most of the weaving sheds where cotton or silk is used, the atmosphere is fairly moist, and this is detrimental to obtaining the best results with vanduara, as its strength is reduced. In our own mill, and in weaving factories with a dry atmosphere, there is no difficulty in working it, and the results have been very satisfactory.

The process of aldehyding the thread which we use certainly renders it insoluble in water even if boiled for a short period, but its strength or tenacity is very much reduced. Aldehyded gelatin, if a true chemical compound at all, which I doubt very much, is certainly not a very stable one, as prolonged boiling with water splits it up and the gelatin becomes soluble again, and it is quite a mistake to say that it renders gelatin waterproof, although it certainly reduces its affinity for water very considerably.

If some reagent can be found which would prevent the thread losing its strength when subjected to moisture, we would be able to produce a material little, if any, inferior to real silk, and certainly very much superior to the weighted silks which are so common.

Many receipts are published, some being even patented, for the production of so-called waterproof glues or gelatin, but as far as my experience goes I have not found them to be waterproof to any extent. In most of the receipts published for producing special qualities in glue and gelatin the ingredients are mixed in proportions which seem to be fixed entirely by rule of thumb, and in a great many instances I doubt very much if any satisfactory reason could be given for their use.

So far the bulk of the reagents mixed with gelatin have been almost entirely inorganic substances. The principal inorganic salts which have any reaction with gelatin are:—Alum, which coagulates it, but on continued heating the gelatin becomes quite homogeneous and fluid. Aluminium chloride and aluminium acetate are similar to alum. Potassium bichromate is said to render gelatin waterproof after being exposed to light. I have never found it so; all that could be said is that it renders it soluble with difficulty. Ferric salts have the strongest action on gelatin, precipitating the gelatin in flaky lumps, which do not become homogeneous on continued boiling.—The Journal of the Society of Chemical Industry.

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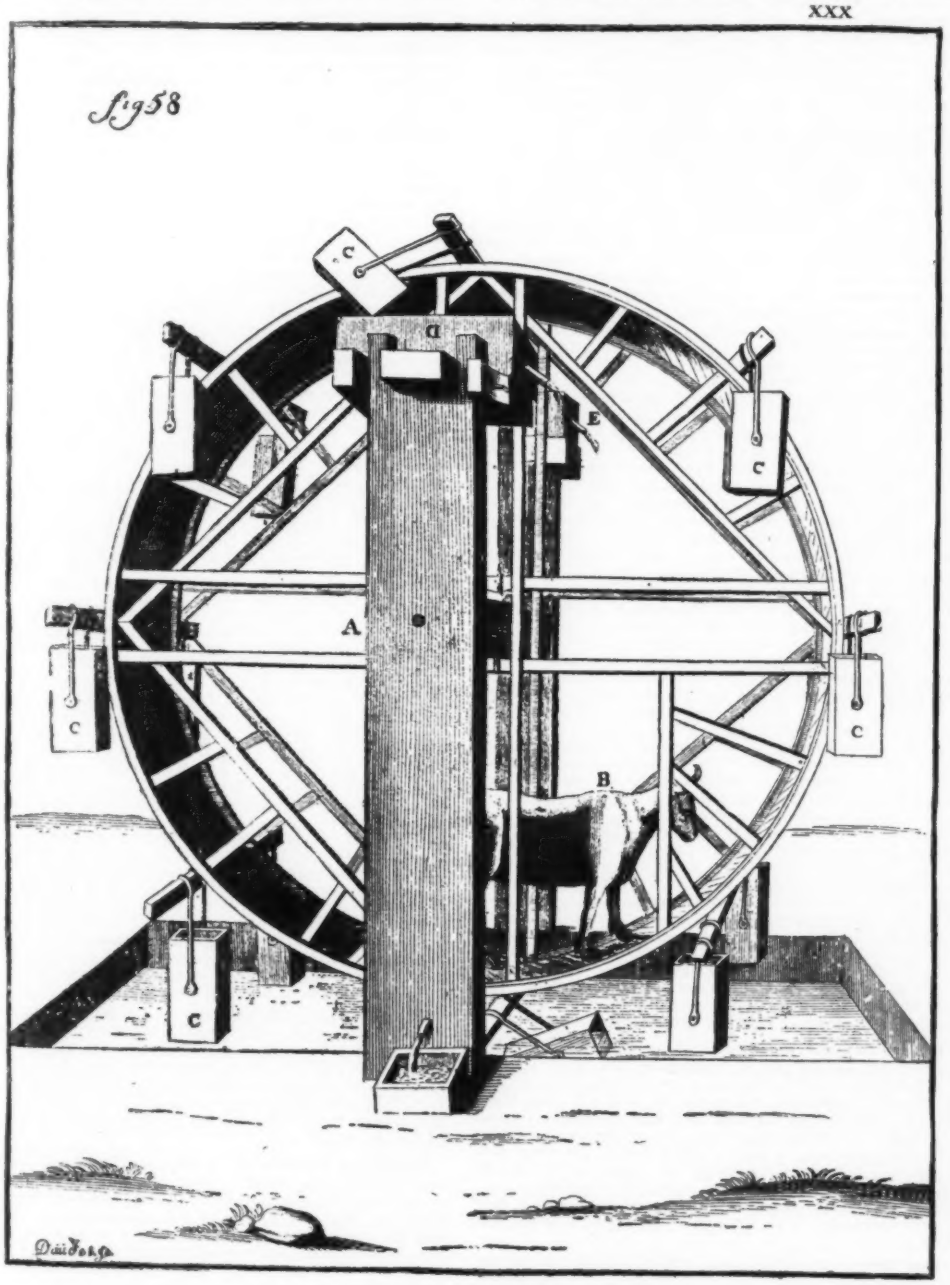



FIG. 2.—MACHINE FOR RAISING WATER.

## JUTE STATISTICS.

IN the year 1795 Dr. Roxburgh, the distinguished botanist, then residing in India, showed a bale of fiber prepared by himself from the stalk of one of the two species of jute plants. The fact that Dr. Roxburgh first used the word jute to indicate Jhot, the most popular vernacular name for the fiber in Bengal and the way in which he used it, "the jute of the natives," suggest the idea that he got it from the people about him in the botanical gardens at Sibpore. These people were most likely the mallies (gardeners) employed at the garden, and who, as a rule, are natives of Orissa, and since Jhot is the prevailing name for jute in Orissa, the inference is that Dr. Roxburgh got the word from his Orissa mallies, and that Europeans have since followed him in using the word.

The cultivation of jute is stated to have been going on in small quantities for local requirements from time immemorial. In Norvgong it is stated to have been known so far back as the last decade of the fifteenth century, when the use of the fiber for tying up books was expressly prohibited by the Sunkar and Madhow. According to reports from district officers and reliable old inhabitants, the cultivation of jute has been carried on more extensively in the district of Bogru (Rajshaye Division), 208 miles from Calcutta, since the year 1847, and in the districts of Tipperu and Noakhali (Chittagong Division) since the year 1854. Nymonting and Rungpore are the two largest jute-growing districts in the whole of India, the former in the Dacca Division, and having a population of nearly 3,500,000, and an area of 6,322 square miles, equivalent to 4,052,480 acres, out of which 550,000 acres is under jute cultivation, and a little over 2,400,000 under rice, the greatest rival of jute. The remainder is under various other produce. The latter district (Rungpore) is bounded on the east by the river Brahmaputra, which separates it from the former district (Nynomting). It has a population of over 2,000,000, and an average acreage of 272,000 acres under jute. The cultivation in these two districts has been gradually spreading since the year 1849, but the extension has been specially notable there since the cultivation of indigo was abandoned in the former, and immensely curtailed in the latter district.

The jute of commerce is obtained from two different species of plants, both belonging to the same natural order—Tiliacæ (elm or linen tree group). The order embraces several genera, the bark of which yields fibers; but of these the genus Corchorus is the most remarkable, as including the two species of valuable fiber-producing plants from which the entire jute of commerce is obtained at the present day. It is an annual plant, growing five to ten feet high, sometimes higher, with a cylindrical stalk as thick as a man's finger, and seldom branching, except near the top. The leaves are of a light green color, about four to five inches long, and about one and a half inch broad at the base, but tapering upward into a long sharp point at the apex. The edges are cut into teeth, the two teeth next the stalk being prolonged into thread-like points. The flowers are small, and of a whitish-yellow color, in clusters of two or three opposite the leaves. The seed pods are short, globular, wrinkled and rough. The other plant is precisely similar in general appearance of the plant, shape of leaves and habits of growth; but it differs entirely in the formation of its capsules or seed pods, which, in this species, are elongated (about two inches long), almost cylindrical, and about the thickness of a quill.—The Textile Mercury.

**A New Textile Plant.**—Consul Atwell, of Roubaix, under date of May 11, 1900, writes:

On July 18, 1899, I made a report on the Apocynecis or Apocynum venetum,* a textile plant growing wild in Asia Minor, Indo-China, and Japan. Since that time samples of this plant have been received in Lille, Rouen, and the Vosges, where tests have been made, both in the dry state and after three months' submersion in water, to establish the power of resistance of the Apocynecis compared with that of flax. It is said that the strength of the Apocynecis is 50 per cent. greater than that of flax. These tests have been carried on with great secrecy, and I have not been able to get more information than that herein given. I inclose a small sample of the plant.† It is sold in Cambodia for 7 francs per 100 kilogrammes ($1.35 per 220·46 pounds).

* See Consular Reports No. 229 (October, 1899); Advance Sheets No. 513 (August 26, 1899).

† Sent to Department of Agriculture with copy of the above report.

## TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

**Railway Station at Nottingham.**—Consul McFarland writes from Nottingham, May 25, 1900.

A new railway station, one of the largest and finest in England, was opened for traffic in this city yesterday. It was built by two roads—the new Great Central and the Great Northern—and is in the heart of the city, being entered from each direction by tunnels. It covers 12 acres and costs slightly in excess of £1,000,000 ($4,866,500). Five hundred and eighty thousand cubic yards of material were removed from the site, and the platform frontage, of solid masonry built to car-floor height, aggregates 2 miles. The largest station in Britain is the Waverly, at Edinburgh, covering 23 acres. Liverpool street station, London, covers 22½ acres. Next to the new Nottingham Central, now the largest in the provinces, comes New street, Birmingham, covering 10¾ acres. All of these stations are of the most substantial pattern, being constructed entirely of stone, brick, and iron.

**United States Locomotives in Egypt.**—Many and impressive evidences of the efficiency of the United States system of building up and promoting home industries are afforded by the recent rapid expansion of our exports of manufactured goods in all parts of the world, and especially in Egypt. While our makers of agricultural implements and machinery are just beginning to properly appreciate the value and importance of the new field in the great valley of the Nile, it will be observed from the following extracts from the report of Lord Cromer, British Agent and Consul-General in Egypt, on the finances, administration, and condition of Egypt and the Soudan in 1899, that American builders of railway locomotives, whose foresight and enterprise carried them into successful competition with the English here a few years ago, are still holding the field, and it may be confidently assumed that they are here to stay.

Under the head of "railways," Lord Cromer says:

"Large additions were made to the rolling stock in the course of last year. Most of the new stock added is, however, to replace old stock which had been condemned. I may mention that four trial heavy engines, exceeding in power the largest locomotives in use on the English railways, were ordered last year, viz., two from Messrs. Dubs, of Glasgow, and two from America. On the subject of various works now in progress, Captain Johnstone, the acting president of the railway administration, writes to me: 'They form but a small part of what is required, and I trust that funds may soon be available for the various urgent services, more especially in connection with the port of Alexandria and the Cairo goods yard, which the administrations have from time to time brought before the government for approval.'

"On this point I can only repeat what I said last year. There can be no doubt that railway progress in Egypt has not kept pace with the growing prosperity of the country. What is now required is that a considerable sum—say, one and a half millions—should be borrowed, in order to enable the railways to be put into thoroughly good working order.

. . . . . .

"I am glad to say that the only locomotives recently supplied by an English firm—Messrs. Neilson Reid & Co., of Glasgow—have not given the slightest trouble. Those purchased from America in 1898 have also done well; but, as they differ in many respects from our standard types, our men have taken some time to learn their peculiarities, and we have not been able to get the best results out of them.

"The action of the board in ordering locomotives and wagons from America has been criticized. It is due simply to the fact that American firms, while they are not in a position to tender on more favorable terms than others on our designs, almost invariably offer us engines or wagons built to standard designs of their own at lower prices and in less time, while English and other European makers content themselves with tendering on our designs, being, as a rule, not in the habit of manufacturing to standard designs of their own. We much prefer adhering to our own standards; but in cases where time and cost are of great importance, such an offer from America cannot be passed by. On the other hand, the length of time required at present by competent English firms to execute such orders is prohibitive, and the only order placed for locomotives this year, besides the trial orders referred to elsewhere, went to a Belgian firm, who offered delivery in three and a half months less than any English firm, and who have done good work for us in previous years."

The above observations of Lord Cromer refer to the year 1899. To-day there are forty-six American locomotives either in use or ordered by the Egyptain railway administration; three hundred and seventy-one cars are in use, and orders for four hundred more cars have been placed. The superiority of American engines and cars, as well as of all other railway equipment and supplies, is conceded by railway officials and experts, and the demands upon our shops will continue to grow with increasing rapidity.

The people of the United States may look with pardonable pride upon our success in furnishing electrical engines for London, locomotives for railways in India and Great Britain, iron bridges for the Soudan, and machinery and manufactured goods for all countries. Having supplied our own markets, we now send forth the machinery that is to aid civilization in all parts of the globe, from the burning deserts of the Soudan to the frozen fields of Siberia.—John G. Long, Agent and Consul-General at Cairo.

**Trade of the Philippines in 1899.**—Consul Halstead sends from Birmingham, June 11, 1900, the following abstract of the annual report of the British Consul at Manila:

"The collapse of the insurrection last November and the opening of the ports since January 1 having restored confidence, great activity in commercial quarters has ensued; but the continuation of this prosperous state of affairs is very much dependent upon circumstances, for, though the ports are safe, the interior of this island and of many of the others is quite the contrary. When the accumulated cargoes now in these ports are disposed of, it will depend on the state of the country whether any further exports are forthcoming. Law and order are being restored as rapidly as possible, but the immense size of the country renders it a difficult task. The natives, I believe, would willingly return to their agricultural pursuits, but the influence of their leaders appears sufficiently strong to keep them from surrendering.

"Prices have increased to such an extent that Manila, which till recently might be classed as a cheap place to live in, must now be considered the reverse. As yet the provision markets are not seriously affected, though fruit, vegetables, game, etc., are 20 per cent dearer; but house rent, servants, carriages, horses, launches, and labor of every description are already treble the price of last year. In consequence of the great demand, launch hire and everything connected with shipping commands its own price. Improvements are visible in every direction, and already the town has quite a different appearance from last year. The work of draining the filthy town ditches and stagnant pools, which is in contemplation, may possibly entail an epidemic, but the advantage to posterity is inestimable. The recovered land of the city walls and moat will provide building sites which American enterprise will know how to utilize; and, although Manila will never become a fashionable watering place, it may become a great commercial power in these waters before the first quarter of the century is passed.

"The two well-known leading industries of Manila—hemp and tobacco—will, I fear, suffer very severely for some time from the late insurrection; but there are no doubt at present golden opportunities for the employment of capital and talent in many local trades. Ice manufactories, livery stables, hotels, and general enterprise are much wanted; but I most strongly deprecate young men without capital (no matter what their education may be) coming here in search of employment. The departments of the post-office and telegraph, being now under American and British control, are admirably conducted. The telephone, the water supply, and the electric lighting are Spanish, and also deserve great praise. The electric lighting plant is being enlarged, and Manila will soon be one of the best lighted towns in the East.

"The Chinese labor question is one of great importance in these islands. America's experience of it in California not being satisfactory, there is strong influence against it; but taking into consideration the natural indolence of the Filipino, it will probably be found impossible to do without the Chinese. One of the principal objections is that by their industrious habits they gradually obtain a monopoly in all retail trades; but this may be remedied by confining their enterprise simply to manual labor, and for this they are most admirably adapted, and in the hot season positively necessary. The Filipinos make excellent clerks if they can be well overlooked; but if allowed, they will spend their time in gambling and cockfighting. They have no idea of putting energy into any of their pursuits, and have no commercial instinct; they also care little for money, loss or gain being to them apparently a matter of indifference."

A copy of the report to which Mr. Halstead refers having been received by the Bureau of Foreign Commerce, the following extracts are added.

The British Vice-Consul at Iloilo says:

"The United States forces having now successfully occupied the better part of the island, the end of this year augurs well for a happier future, and, when once a peaceful rule is established, many important improvements will take place.

"The Island of Negros is in a more satisfactory state, and, although the crops for 1900 may not be very large, owing to the difficulties which had to be overcome in procuring labor, the planting for the 1900-1 crop, I have reason to believe, is extensive."

The Vice-Consul at Cebu reports that the China Steam Navigation Company has just commenced to run a regular steamer from Hong-kong to that port via Manila and Iloilo, and no doubt other companies will follow this example, as there seems a good prospect of this enterprise giving a favorable result. Hemp was exported from Cebu last year to the value of £647,675 ($3,151,910); sugar, £158,328 ($770,503); copra, £49,716 ($241,953). The total shipments exceeded by some £300,000 ($1,456,000) those of the year 1898. Imports (consisting largely of petroleum, rice, salt, and coal) were valued at £216,847 ($1,055,286).

**Italian Demand for Locomotives and Cars.**—Acting Consul Monaghan writes from Chemnitz, May 18, 1900:

According to several newspapers of Milan, the Italian Minister of Railroads has empowered the Italian Meridional, Mediterranean, and Sicilian railroads to call for bids for 123 locomotives, 460 baggage cars, and 2,673 freight cars, valued at $8,878,000. For the construction of these, competition is open to the world. It seems to me that some of our large builders of locomotives should stand a fair chance of getting part of these orders. I am unable to give the time limit of bids.

**Egg Exports from Madeira.**—The following has been received from Consul Jones, of Funchal, dated May 5, 1900:

The export of eggs from Madeira to South Africa since 1897 has been:

| | |
|---|---|
| 1897 | 2,122,286 |
| 1898 | 4,054,826 |
| 1899 | 5,298,820 |
| 1900 (from January 1 to April 1) | 2,067,000 |

The United States should command this trade. Madeira is fourteen days from Cape Town. Eggs are put up and shipped from here in most primitive manner. With our advanced means of preserving and methods of carrying, our eggs should command a better price, and the market is without limit. Eggs could be shipped from America via Southampton to catch the fast-mail steamers, and would be only a week older than Madeira eggs when they arrive at destination. Eggs are taken from central Russia to South Africa, arriving there in good condition. Eggs sell in the market here at $3 per hundred.

**India's Cotton Crop.**—Consul-General Patterson, of Calcutta, under date of May 23, 1900, writes in regard to the figures in his report printed in Advance Sheets No. 663, February 26, 1900 (Consular Reports No. 236, May, 1900), as follows:

The Director-General of Statistics to the government of India reported the crop of 1898-99 to be 2,416,503 bales of 400 pounds each, not 1,365,864 bales, as copied by mistake in my report. He also estimated, in his third memorandum on the cotton crop dated December 30, 1899, that the crop of 1899-1900 would be 641,327 bales, as stated in my report, a little more than one-fourth of the crop of 1898-99 and of the average for the past five years, which was 2,308,424 bales.

**Greek Currant Crop.**—Consul Darte, of Patras, under date of May 31, 1899, reports:

Greece has seen this year the worst weather, it is stated, that has been experienced for the last forty years, with changeable temperatures and heavy rains. This has greatly affected the currant vines, and the disease known as peronosporos has shown itself to a considerable degree. In some sections, the decrease in the crop is estimated at 40 per cent; in others, at only 15 per cent. Currant raisers and merchants are greatly exercised over the prospective decrease.

**Swiss Accident and Military Insurance Law.**—Consul-General DuBois, of St. Gall, under date of May 21, 1900, writes: The sick, accident, and military insurance law was voted upon May 20, 1900, and was defeated by a two-thirds vote.

In October, 1890, by a vote of 283,000 against 92,000, the Swiss people adopted a constitutional provision providing for the establishment, by a direct vote of the citizens, of a system of obligatory insurance in case of sickness or accident in which the Government, the employers of labor, and labor itself were to participate. The Government was to provide 20 per cent. of the entire premium, labor 20 per cent., and the employers of labor 60 per cent. The text of the proposed law contained four hundred articles, among which was a military insurance clause that met some opposition among the military classes.

The law has now been defeated by about 195,000 votes. Of the twenty-two Cantons voting, only Glarus gave a majority in favor of the law.

The causes of the defeat of this measure are various. The voters of the agricultural districts considered the law in favor of the industrial centers. Those engaged in house industries were dissatisfied with the provision which made the insurance compulsory for some and optional with others. Strong opposition was also developed among large manufacturers, especially in the silk industry, who were convinced that under the new law they would be more heavily taxed than under the non-compulsory system of insurance at present in operation.

There was another element, called the anti-federal-expense class, which helped to defeat the measure, because the execution of the law would require a large number of new officials, thus increasing the national expenditures.

**Petroleum Industry in Japan.**—Vice-Consul General McLean sends from Yokohama, April 27, 1900, a clipping from The Japan Times, of even date, giving information concerning the rapidly developing petroleum industry in the district of Echigo, Japan, as follows:

ECHIGO PETROLEUM NOTES.

There are at present over thirty petroleum companies in the oil district in Echigo. Some of these possess a capital of over 1,000,000 yen ($498,000), the aggregate capital amounting to 12,000,000 yen ($5,966,000).

In consequence of the increasing activity of the industry, the inadequacy of banking facilities is now being felt by the merchants in the locality and by those having business connections with the place. With the object of affording better facilities in this direction, the First and Yasuda banks, in Tokyo, and the Sumitomo Bank, in Osaka have under consideration the establishment of branches either in Nagaoka or Kashiwazaki.

The proposed scheme to construct a pipe line from the seat of the petroleum wells in Echigo to Tokyo, for the rapid and convenient transportation of kerosene, is now assuming a practical shape. The promoters of the enterprise have decided to intrust the Nakai engineering office with the business of making a preliminary survey for the projected work. Mr. Miyagi, graduate of the engineering college of the Tokyo Imperial University, will act as advisory engineer in the survey, which is to be begun at no distant date.

**Admission of Goods into China for Exhibition.**—Minister Conger wrote from Pekin, April 16, 1900, that he had succeeded in obtaining permission from the Tsungli Yamên to admit, free of duty, the goods to be placed on exhibition in the American warehouse in Shanghai to be established by the National Association of Manufacturers. Bond was to be given that none of the goods would be sold.

**Restricted Production of Woolen Goods in Europe.**—Consul Worman writes from Munich, May 1, 1900:

At a recent meeting of the United German Manufacturers of Worsted Goods in Leipzig (at which 1,400,000 spindles were represented), it was resolved to reduce production from June 1 to December 31, 1900, by 30 per cent. It is understood that the manufacturers of Switzerland, Austria and Russia have agreed to adopt the same course, in order to put a stop to further decline in prices.

## INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

**No. 770. July 2.**—Americanizing the German Shoe Trade—European Demand for Flax and Flaxseed—*Tanning Machinery in Spain—Projected Railway Extension in Mexico—Educational Progress in Eastern Siberia—*Customs Regulations in Canada.

**No. 771. July 3.**—Commerce of Nicaragua—*Swiss Accident and Military Insurance Law—*The Telephonograph—Acreage of Sugar Beets for the Year 1900.

**No. 772. July 5.**—The Liquor Traffic in Russia—Pavements in Switzerland—*Australian Butter Packing—*Cheese of Pasteurized Milk in Sweden—Quinine Auction at Batavia: Correction—Cigarettes in Colombia.

**No. 773. July 6.**—Dentistry in Switzerland—A Commercial School for Tiflis—Steamship Service with Chunking—Italian Electric Cartridges—Diseased Argentine Cattle at Cape Town—Foreign Commercial Travelers in Roumania.

**No. 774. July 7.**—Notes from Dawson: The Koyukuk Region—Egyptian Cotton Industry—Electric Works in Bombay—Tariff in the Canary Islands—Antialcohol Serum in France—Farm Life in Brazil.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

## TRADE NOTES AND RECEIPTS.

**Liquid Glycerin Soap**.—Dissolve 40 parts of white potash soap in 50 parts of glycerin and add 10 parts of spirit of wine to the solution.

**Bay Rum.**—

| | |
|---|---|
| Bay oil | 16 parts. |
| Clove oil | 1 " |
| Piemento oil | 1 " |
| Jamaica rum essence | 75 " |
| Spirit of wine | 2650 " |
| Water | 1850 " |

Mix and filter.

**Bishop Essence.**—To be prepared from:

| | |
|---|---|
| Fresh green peel of unripe oranges | 60·0 grammes. |
| Curaçao orange peel | 180·0 " |
| Málaga orange peel | 90·0 " |
| Ceylon cinnamon | 2·0 " |
| Cloves | 7·5 " |
| Vanilla | 11·0 " |
| Orange flowers oil | 4 drops. |
| Spirit of wine | 1500·0 grammes. |
| Hungarian wine | 720·0 " |

A dark brown tincture of pleasant taste and smell.—Neueste Erfindungen und Erfahrungen.

**Putty for Aquariums.**—

| | |
|---|---|
| 1. Whiting | 6 parts. |
| Gypsum | 3 " |
| Fine white sand | 3 " |
| Litharge | 3 " |
| Powdered rosin | 1 " |

Work with best varnish into a mass resembling glazier's putty.

| | |
|---|---|
| 2. Gypsum | 2 parts. |
| Chalk | 2 " |
| Litharge | 2 " |
| Powdered resin | 1 " |

Mix with boiled linseed oil until a mass resembling glazier's putty results.

An excellent material for tightening aquariums has been found to be a mixture of carthage and glycerin, which turns as hard as stone within a few hours.—Neueste Erfindungen und Erfahrungen.

**Arsenic not an Element.**—According to a note published by Prof. F. Fittica in the Chemiker Zeitung, this chemist has made the discovery that arsenic is not an element, but a nitrous acid compound of phosphorus. This announcement is bound to cause quite a sensation, owing to its great importance from a scientific as well as a practical view point. As far back as in 1892, Flückiger had shown that the "black modification of phosphorus," which results when ammonia gas is caused to act upon phosphorus, either in the light or in a molten state, is nothing else than arsenic. Flückiger, however, supposed arsenic to be dissolved in the phosphorus. Fittica has now proven that arsenic can be synthetically produced from phosphorus. He heated 2 grammes of amorphous phosphorus (free from arsenic) with 12·9 grammes of finely powdered ammonium nitrate, after a careful mixture, in not too thin a tube on a sand bath with cooler, at first slowly ascending to 180° C, when the reaction commences. Same must be reduced if necessary, extinguishing the gas flame employed. When this is done, the heat is slowly raised to 200° C, at which temperature the finish of the now lively reaction is awaited. After that allow to cool, dissolve the mass, a molten substance of grayish-white color, in water, and treat the acid-reacting solution, after filtering with hydrogen sulphide. The yellow precipitate is dissolved in ammonium carbonate and the arsenic sulphide again precipitated therefrom by hydrochloric acid can be recognized by its behavior to ammonia and hydrochloric acid, its conversion into arsenic acid, precipitation of same with magnesium chloride and ammonium, as well as by testing these latter in Marsh's arsenic apparatus.

**The Manufacture of Borax.**—Up to about eight years ago large quantities of South American boro-natrocalcite were worked up by boiling it in powder form with soda solution, whereby it changes into borax and calcium carbonate. It was then filtered off from the lime, the lye left to crystallize, and the borax cleaned by repeated recrystallization. This recrystallization became necessary owing to the large percentage of soda and comparatively considerable one of iron.

According to Nagel, a much simpler process is used to-day, in which the lye is brought to crystallization direct, and the recrystallization is done away with, since the starting material is very pure, and almost entirely free from iron.

The larger part of the borax entering commerce is at present made from borocalcite, a material consisting chiefly of calcium borate, and found in large deposits in Asia Minor, which are exploited by a Lyons company. The chief market for it is Hamburg.

Calcium borate is known to change with soda into borax and calcium carbonate. In the course of the experiments the fact has been established later that sodium bicarbonate may also be employed instead of the soda, and finally it was ascertained that a certain mixture, accurately described below, of sodium carbonate and sodium bicarbonate is the most advantageous for the production of borax.

The process of manufacture is as follows:

The borocalcite is ground in rolling balls mills into a fine flour, and 1,500 kilos of it are heated with four times the quantity of water in a kettle by direct steam. Now add 800 kilos of bicarbonate and 200 kilos of sodium carbonate and continue the boiling for three hours. The mass is next drawn through large filter presses, which are provided with a lixiviating arrangement. The hot lye runs off direct into crystallizing vessels, in which the borax crystallizes out in a few days. The solid crystal pieces are then dried in a steam chamber, freed from all adhering dirt particles, pounded into smaller pieces, assorted into dust chips and crystals, and packed in barrels of 50 to 400 kilos.

The cake of lime carbonate remaining behind in the filter press is washed with water until the borax is completely extracted, and then sold to glass, cement or paper factories. One hundred kilos of borocalcite furnish 100 to 110 kilos of crystallized borax.—Anzeiger für die Gesammte Chemische Gross-und Klein-Industrie.

## SELECTED FORMULÆ.

**For Falling of the Hair.**—Le Médecin gives the following, which is said to do excellent service:

| | |
|---|---|
| Tincture of cinchona | 1 part. |
| Tincture of rosemary | 1 " |
| Tincture of jaborandi | 1 " |
| Castor oil | 2 " |
| Rum | 10 " |

Mix.

**Dressing for the Hair.**—

| | |
|---|---|
| Oil of wintergreen | 20 drops. |
| Oil of almond, essential | 35 " |
| Oil of rose, ethereal | 1 " |
| Oil of violets | 30 " |
| Tincture of cantharides | 50 " |
| Almond oil | 100 grammes. |

Mix. —National Druggist.

**Cleaning Copper.**—

1. Make Armenian bole into a paste with oleic acid.
2. Rotten stone 1 part.
   Iron subcarbonate 3 "
   Lard oil, a sufficient quantity.
3. Iron oxide 10 parts.
   Pumice stone 32 "
   Oleic acid, a sufficient quantity.
4. Soap, cut fine 16 parts.
   Precipitated chalk 2 "
   Jewelers' rouge 1 "
   Cream of tartar 1 "
   Magnesium carbonate 1 "
   Water, a sufficient quantity.

Dissolve the soap in the smallest quantity of water that will effect solution over a water bath. Add the other ingredients to the solution while still hot, stirring all the time to make sure of complete homogeneity.

Copper tubing or other parts of apparatus that cannot be readily cleaned by mechanical means should be well coated with tin.

**Cement.**—An excellent cement for joining broken crockery and similar small articles can be made by melting 4 or 5 parts of resin (or better still, gum mastic) with 1 part of beeswax in an iron spoon or similar vessel. Apply while hot. It will not stand great heat.

**Cinchona Jelly.**—

| | |
|---|---|
| Caffeine | 6 parts. |
| Extract cinchona | 25 " |
| Citric acid | 4 " |
| Tincture vanilla | 1 " |
| Tincture lemon peel | 4 " |
| Rum | 80 " |
| Syrup | 300 " |
| Gelatin | 20 " |
| Glycerin | 80 " |
| Water | 180 " |

—American Druggist.

**To Make Colored Lacquer.**—Make a strong solution of any coloring matter which is soluble in methylated spirit, such as cochineal, saffron, the aniline dyes, etc. Filter through fine cambric, and to this filtered solution add brown shellac in flakes in the proportion of 4 to 5 ounces of shellac to each pint of methylated spirit. Shake once a day for about 8 days. If too thick it may be thinned by adding more colored spirit or plain spirit as required, and any lighter shade can be obtained by mixing with plain lacquer mixed in the above proportions. Lacquer works best in a warm dry place, and the process is improved by slightly warming the articles, which must be absolutely free from grease, dirt or moisture. The best results are obtained by applying many coats of thin light colored lacquer, each coat to be thoroughly dry before applying the next.

Apply with a soft camelhair brush; it is better to use too small a brush than too large. When complete, warm the articles for a few seconds before a clear fire; the hotter the better; if too hot, however, the colors will fade. This makes the lacquer adhere firmly, especially to metallic surfaces. Aniline green works very well.—J. Pool, Milparmka, New South Wales, Australia.

**Cheap Dipping Paint.**—In painting many things there is a distinct advantage in dipping them into the paint itself rather than applying the paint by means of a brush in the ordinary way. Barbed wire is a good example, as it is very troublesome to paint with brushes, and the painting machines are very little better. An exchange gives the following recipe for a cheap dipping paint suitable for the purpose. Take 15 gallons of coal tar, 12 ounces of rosin, 1½ pounds of lamp black, 15 pounds of finely sifted fresh slaked lime and 3 pounds of tallow. First melt the rosin and tallow, mix and add the coal tar, then break up the lamp black in gasoline to a thick paste and stir in a pint of boiled linseed oil, mix this with the lime, then stir the lime and coal tar mixture together and use the mixture while hot. If preferred to use a cold dip, thin the coal tar with turpentine or benzine until it is of the right consistency. In either case sufficient Japan must be employed to make the paint dry hard.

**Line Drawings on Photographs.**—A correspondent writes us as follows: We had occasion this week to make for the Province Publishing Company line drawings from photographs. We made from the negatives prints on Eastman's Dekko paper in the usual way and sketched on them as usual with waterproof India ink and bleached the photo with:

| | |
|---|---|
| Cyanide of potassium | 1 ounce. |
| Water | 8 " |
| Tincture of iodine | ½ " |

The result when dry was black lines on perfectly white paper. We have never seen this formula in any photo journal, and thought it might be of interest to some of your readers.—Edwards Bros.

**Bleaching Linseed or Poppy Oil.**—The Siefensieder Zeitung gives the following recipe for bleaching linseed or poppyseed oil: Stir up 100 pounds of the oil with a solution of 2 pounds potassium permanganate in 5 gallons of water. Leave twenty-four hours in a warm place, and then add 3 pounds of sodium nitrate in powder. Stir till this is dissolved, and then add 4 pounds of commercial hydrochloric acid of 20 degrees B. Finally neutralize with chalk-milk, and filter through calcined Glauber's salt.

## ELECTRICAL IGNITION FOR GAS AND GASOLINE ENGINES.

By P. P. NUNGESSER.

IN the early days of gas and gasoline engine construction, the only method of ignition was by what was commonly known as the hot tube. The tube which entered the combustion chamber or cylinder was heated to redness by a gas or gasoline burner, which necessitated the maintaining of an open flame outside of the engine cylinder. The many dangers accompanying this form of ignition, especially on gasoline engines, made it, in some localities, extremely hazardous, while there is an uncertainty in the period in which the ignition would actually take place due to high or low compression. Under favorable conditions, such as tight-fitting cylinder rings on the piston head, and perfect fitting valves, whereby high compression was obtained and the explosive mixture forced into the hot tube at a pressure corresponding to the igniting temperature, the ignition would take place at a proper period of the stroke, and high efficiency was the result. But a slight leakage at the rings on the piston head lowered the compression which, together with the frequent breakage of the heat tubes, due to the oxidation and other uncertainties of this method of ignition, soon led the inventors and manufacturers of gas and gasoline engines to seek a more reliable means of ignition, free from the many dangers accompanying the use of the hot tube.

This method was found in the application of the electrical igniter to such engines. However, many builders of gas and gasoline engines have frequently met with difficulties, and sometimes failures, in their efforts to obtain satisfactory results in the electrical ignition under the various conditions existing. This is due to the many details which are overlooked and regarded by many builders as unimportant.

The great strides that have been made in the perfection of the gas and gasoline engine, especially adapted for automobile service as well as all forms of stationary motive power, has made this a very important industry, the growth and magnitude of which can hardly be conceived by those not directly or indirectly interested in this progressive industry. The high state of perfection met with to-day in this important source of mechanical energy as applied in its comparatively new field of usefulness on automobiles and pleasure yachts, is due, in a measure, to the great improvement made in the electric igniters, spark coils and batteries. Perfect ignition is the most important factor in producing successful results. Engines which have igniters that combine durability with simplicity of construction have met with the greatest success in the hands of the average operator.

The writer will endeavor to explain the most successful igniting devices in use at the present time. They consist of two distinct classes—the primary and the secondary—the latter commonly called the "jump spark" igniter. The primary igniters, which are by far the most largely used by the engine builders in this country, are constructed in three distinct forms. The first, known as the striking or "make-and-break" contact, employs points which are made to pass through the side of the cylinder or through the cylinder head into the combustion chamber. The movable point which strikes against the stationary point is actuated by a suitable mechanism on the outside of the cylinder. This mechanism is usually so arranged that ignition can be produced at the highest point of compression, or at the point where the highest efficiency is obtained with the combustion mixture employed.

The second form of primary ignition, commonly known as the rotary or wipe-spark igniter, is not so largely used as the striking or make-and-break type just described. One objectionable feature which the writer has not yet seen successfully overcome in the rotary type, is the great wear in the sliding contact points. It is true this form of ignition produces a much larger spark with the same consumption of battery power than the striking or make-and-break igniter, but the frequent attention that this form of sliding contact ignition requires to keep it in perfect condition will prevent it from ever coming into so popular favor as the striking or make-and-break ignition.

The third form of primary ignition used is the make-and-break igniter known as the inside igniter. This igniter is constructed by passing an insulated stationary rod through the side wall of the cylinder, or through the cylinder head. The movable part of this igniter is attached to the piston head inside of the cylinder, and when the piston head compresses the explosive mixture to the highest point of compression, the igniter, which has been brought in contact by the forward motion of the piston, is separated by the movement of the piston head, thereby igniting the mixture. There are many other forms of primary ignition in use, but those described above are the most largely used in this country.

The second class of igniters, commonly known as the jump spark igniters, have only one form of construction. This is an insulated plug through which the wires from the induction or secondary coil pass to the inside of the combustion chamber. The two wires which pass through the insulated plug are usually spaced from one-half to five-eighths of an inch in passing through the plug, and curved inward or toward each other to allow from one-eighth to five-sixteenths of an inch air-space through which the spark passes from the positive to the negative wire. It will be noticed that no movable parts exist in this form of ignition. When the battery is closed by suitable insulating plates on the revolving shaft of the engine, a spark is produced in the combustion chamber or cylinder.

The insulating plugs used for this secondary current or jump spark ignition, must necessarily have very high insulating properties. They are usually made of so-called lava or soapstone, or of mica having high insulating properties.

The Rhumkorff, or induction coil, as it is sometimes called, which is used to produce the jump spark, is constructed with a primary coil of coarse or heavy wire having a soft iron core. Over the primary coil is wound a great many layers of very fine, insulated copper wire having no metallic connection with the wires of the primary battery coil.

When a battery current passes through a primary

coil, it magnetizes the iron wire core, and also charges a tinfoil condenser, usually placed in the base of the coil. When the battery circuit is closed, a current of very high voltage is produced by induction in the secondary coil, the ends of which terminate in the ignition plug inside of the combustion chamber. This high voltage causes a spark to pass from the positive to the negative wire inside of the combustion chamber.

To ignite an engine successfully with any of the above forms of ignition, a battery of great strength and durability is absolutely essential. These requirements have to be met by a closed circuit battery manufactured expressly for the purpose. Practical tests and demonstrations on automobile and yacht engines have shown that a battery having from 4½ to 6 volts, or ¾ to 1 volt per cell is required. The battery should have a very low internal resistance, and have an amperage or discharge rate of from 8 to 16 amperes on closed circuit measurement.

Too much cannot be said about the use of a suitable primary spark coil in connection with any of the primary igniters. It has required many tests to determine the correct resistance for a coil. If the resistance is too low, the coil will allow too large a flow of current from the battery, thus wasting very much of the battery power, and also frequently destroying the platinum points on the igniter. To obtain the best results, from 1½ to 2 amperes should be the limit of discharge through the coil. Coils are now wound for 4, 6 and 8 cells, as the case may be.

Since the early days of electrical ignition, many forms of spark coils have been used; in fact, any coil that would produce a large spark was considered the correct coil to use irrespective of the great waste in battery power. Many spark coils in use to-day are wasting as much current as is required to successfully ignite the engine. This is due to the very low impedance of such spark coils, which allows a greater quantity of current to flow through the coil when the circuit is closed than is necessary for successful ignition. This waste of current is prevented by having the correct impedance in the coil so as to produce a reliable spark and prevent any waste in the battery power. It has been found from actual tests on modern engines that by having a coil of the correct impedance, the life of the battery may be doubled.

Another great improvement in ignition and saving in battery power was effected by discarding the old style long coils, which were 8, 10 and 12 inches in length, an erroneous idea having existed that a long coil would produce a larger spark. Practical experience and tests have shown that a primary spark coil best suited for high speed engines, such as used on automobiles and pleasure yachts, should not exceed 6 inches in length over all. The 8, 10 and 12-inch coils will not, with the same consumption of battery power, magnetize and demagnetize as rapidly and completely as the 6-inch coil; consequently the latest improved primary coil has an extra large diameter core, which is composed of No. 20 annealed Swedish iron wire, reannealed after cutting to 6 inches in length. A coil having a core made of this grade of iron and with this degree of care, will magnetize and demagnetize instantaneously. This enables the engine builders to provide for only a short duration of close; that is, allowing the circuit to remain closed less time than would be required to produce the same results with an 8, 10 or 12-inch coil. It is, therefore, a great economy in battery power to use a 6-inch coil, and the results are much more satisfactory.

Another important feature in the construction of primary spark coils for automobile use is the thorough waterproofing of the spark coil to produce thorough insulation under all conditions met with in portable use. No spark coil, if not proof against dampness and moisture, will give satisfactory service for any period of time; it is, therefore, necessary to have the spark coil thoroughly waterproof.

In the opinion of the writer, no form of dry battery should be employed for continuous use. The first cost of a dry battery and sal-ammoniac battery is very low, but its life in heavy service is very short.

Dry batteries are sometimes used for starting an engine where a dynamo is used for continuous ignition. A number of builders are using dry batteries for starting their engines, and as soon as the required maximum speed is obtained, an automatic switch cuts the battery out of the circuit and closes the dynamo circuit. This is also sometimes accomplished with a two-point switch, and the dynamo will then ignite the engine until the speed is reduced. While the dynamo or generator is used, the batteries are at rest.

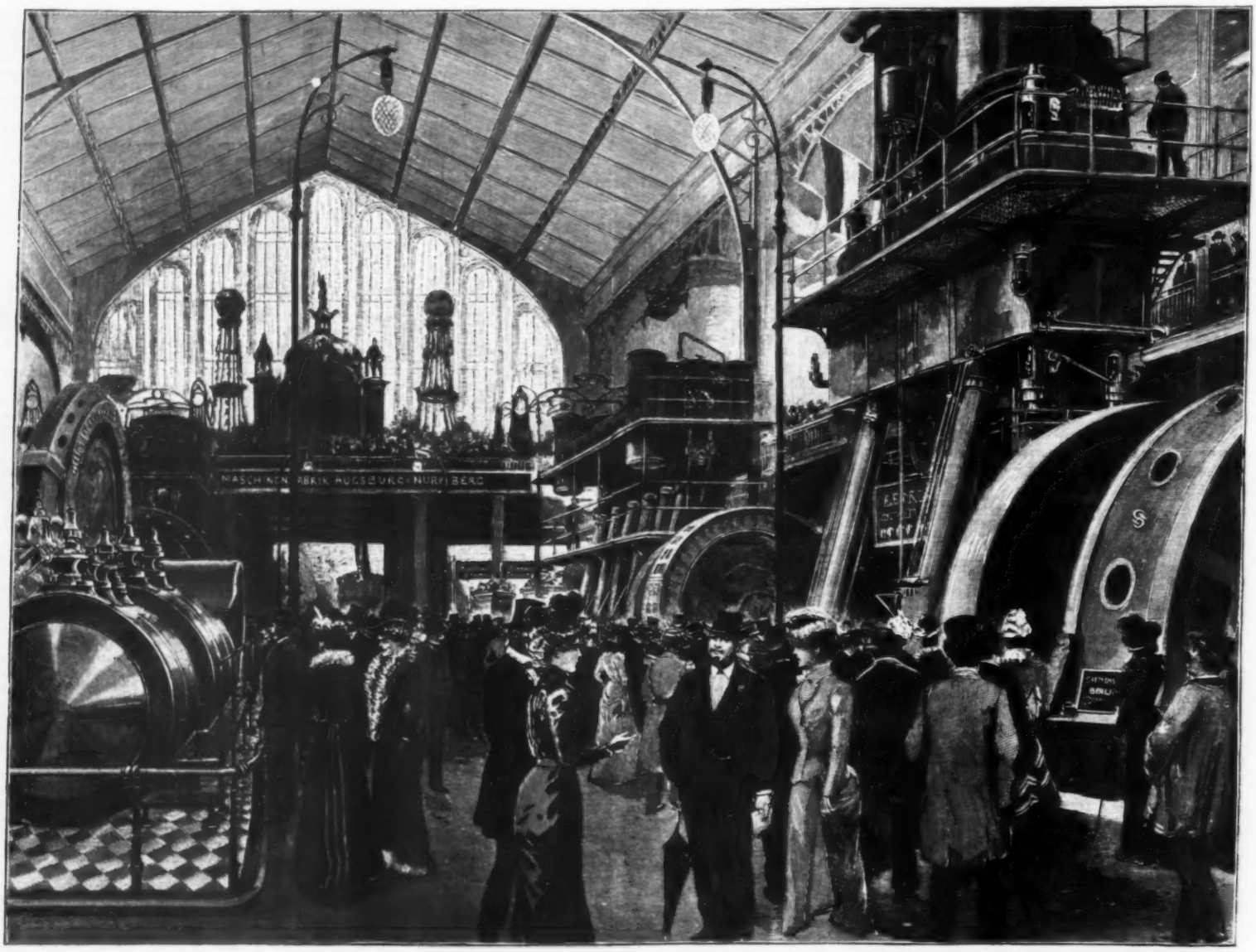
The writer considers a good portable closed circuit battery not only more economical than the dry battery and dynamo combination, but it requires less care, as there are fewer parts to become disarranged in the rough service to which ignition devices are subjected to in gasoline propelled automobiles and pleasure yachts. It is a mistaken idea that dynamos or magneto-generators do not require any attention or repairs. The high speed at which these generators are usually driven produces considerable wear on the movable parts, so much so as to have caused them to be abandoned by many of the progressive builders.

Many builders of automobile and yacht engines have had difficulties, no doubt, with the many forms of closed circuit batteries. These difficulties are sometimes easily located. A closed circuit battery in which a paraffine oil must be used on the solution, is objectionable, as it will be found to give short life and comparatively poor service, for the reason that the rough usage in carriages and boats cause the paraffine oil to coat the elements and interfere with the action of the battery. A perfectly sealed or liquid-tight battery does not require any oil to protect the solution from the atmosphere. A battery which may show excellent service in stationary use may be a complete failure in portable use.

There are no trade secrets about electrical ignition. The degree of success that the various manufacturers are meeting with depends entirely upon the amount of attention that has been given to the most important details, which the writer has endeavored to explain in this article. There are perhaps other causes for success or failure in electrical ignition, but those referred to in this article are from the writer's personal experience, and observations made in the past ten years, or since the development and perfection of the gas engine.—Electrical World and Engineer.

## THE FOREIGN POWER SECTION OF THE PARIS EXPOSITION.

IN the SCIENTIFIC AMERICAN SUPPLEMENT, No. 1276, for June 16, there is an illustrated article on the "Power Generating Plant of the Paris Exposition," but no general view was published showing the relative location of the various engines. We now present an engraving, taken from Illustrirte Zeitung, representing the present actual appearance of the power plant. All of the power required for lighting and working the varied machinery of the Exposition is located in the Palace of Electricity, the front of which is masked by the immense fountain known as the "Château d'Eau." In the rear of this ornamental façade, which terminates the lower end of the Champ de Mars, is the colossal hall, built entirely of iron and glass. It is 426 feet long, 98 feet wide, and proportionately high. On the ground floor are the powerful engines and dynamos, which serve to generate the current. On the first floor are located the exhibits of the various sections devoted to electric lighting, telegraph, telephone, etc. Half of the building is given up to foreign engines and dynamos and half to French-built engines and dynamos. The boilers are directly in the rear of the generating plants, and the two stations are entirely distinct, each having its separate chimney. There are ninety-two boilers in the two stations. Steam is generated at a pressure of 156 pounds per square inch, and it is used at the engines at 140 pounds pressure. At the extreme right of our engraving will be seen a vertical engine made by Borsig, of Berlin; it is built to develop 3,000 horse power, but at the steam pressure allowed it will give 2,500 horse power. At the end of the shaft is a dynamo built by Siemens & Halske, Berlin, giving three-phase current at 2,200 volts. The armature is stationary and surrounds a revolving field. The other engines are furnished by the Nuremberg Engine Company of 2,000 horse power, the Nuremberg & Augsberg Consolidated Company, and the Augsberg Engine




INTERIOR OF THE POWER GENERATING PLANT OF THE PARIS EXPOSITION—FOREIGN SECTION.

Company. The engine shown on our left is an Augsberg engine driving a Helios alternating current generator. The power generating plant is one of the most interesting features of the Exposition, and the halls are constantly thronged with visitors, whose watches suffer greatly from magnetization.

## THE BAMBOO BEAR OF TIBET.

WE publish to-day an engraving of the æluropus melanoleucus, by some called the "bamboo bear" because its chief nourishment is the bamboo and its favorite haunt the impenetrable thickets of bamboo found in the vast mountain forests of eastern Tibet at an elevation of from 9,000 to 13,000 feet above the level of the sea, which is a height as great as the tops of some of the Alpine peaks which are covered with perpetual snows. The rivers which form the Mekong and the Yangtse-kiang have their source in these regions of Central Asia which are so difficult of approach, and here we find great numbers of wild animals that are entirely unique; for instance, the takin, a strange ruminant that reminds one of the African gnu and of the musk-ox of the far North; the snub-nosed apes of the rhinopitheeus genus; and the bear shown in our engraving, which was discovered by the Jesuit priest, Armand David. This bear is of about the same size and general form as a brown bear which has not yet attained its full growth, but its head is shorter and broader, its forehead more arched and the soles of its feet are much more hairy than those of the ordinary bear. Very little is known of its habits, but it is said to live entirely on vegetable substances, it can climb trees very nimbly when pursued, and it hibernates. The Chinese call it "pei-ssjun" (white bear) or "chnassjun" (pied bear). It is white with black ears, a black band around his body, black legs, the end of its stubby tail is also black, and there is a black ring around each eye. In the structure of its skull and the formation of its teeth it is related, among living animals, to the panda æluros of the eastern Himalayas, but is still more closely connected with the hyænarctus genus, long ago extinct, which in Miocene and Pliocene periods inhabited Central Asia, Further India and Europe. Specimens of the æluropus melanoleucus are found only in a few of the large museums of Europe.

For the accompanying engraving and the above data we are indebted to Die Gartenlaube.

## THE MEANS OF DEFENSE OF ANIMALS.—V.*

### PROTECTION AGAINST CLIMATIC CHANGES.

THE changes which we here call climatic are such as are produced in the medium in which animals live, be it air, water, or earth. Changes of temperature may affect all of these media; so, also, may the proportion of water in all of them change: winds and waves may so shift the relative parts of these media as to produce very decided, if temporary, changes in them. All of these changes may seriously affect the animals living in such media; but when they occur periodically, however, protection against their disastrous effects may be obtained; and we now propose to examine some of these defenses.

1. With respect to the effects of temperature upon animals, and the defense which the latter may make against them, Quinton (1896), has made some suggestions of a general kind which are quite interesting. The temperature which presides at the chemical reactions of life (that is, in the processes which are involved in digestion, respiration, etc.), is due to two factors: first, the temperature of the surrounding medium; secondly, the heat-producing power peculiar to the animal itself. The fossil flora shows that the temperature of the globe has been constantly decreasing. Invertebrates and lower vertebrates possess little or no power to raise their body-temperature above that of the surrounding media. Since these animals made their appearance at times when the globe was much warmer than at present, they did not then need such a power. Various reptiles and fishes to-day show body-temperatures considerably higher than that of man when they live in highly heated atmosphere, or highly heated water—temperatures which would indicate a feverish condition in him. On the other hand, when the temperature of the surrounding medium falls, their temperature falls also, and they become more or less torpid. Yet they survive, because of certain modifications of their vital chemical phenomena. The principal fact of this kind known is while the pepsin of the gastric juices of mammals digests food only at about 38° C., that of a reptile is still active when the temperature is near the freezing point. As the earth became cooler and cooler, Quinton says that animals became divided into two groups: one of ancient, the other of recent appearance on the globe. The members of the ancient group, having ceased their evolution at warmer periods of time, have only acquired a feeble heat-producing power, the feebleness of which is proportional to their antiquity. That is, the less the power which an animal possesses of producing heat within itself so as to raise its own body-temperature, the older that group of animals is with regard to its appearance on the earth. Here he places the duck-bill, with a body-temperature of 25° C., when the surrounding temperature is 20° C; the Echidna, whose body-temperature is 30° at 19° of the air; the opossum, 33° at 20°; the armadillo, 34° at 16°; the hippopotamus, 35·3° at 11°; the vampire bat, 35·5° at 18°; the elephant,

THE ÆLUROPUS MELANOLEUCUS.

* Closing lecture of a series delivered January and February, 1900, at the Academy of Natural Sciences of Philadelphia, by Philip P. Calvert, Ph. D., of the University of Pennsylvania. Copyrighted, 1900, by Philip P. Calvert. Revised by the author.

35·9° at 11°, and so on increasing. All these temperatures are lower, more or less, than that of man, whose body-temperature is 37·5°. The second, or modern, group consists of animals which, having prolonged their evolution into the colder ages, have progressively acquired a greater heat-producing power, tending thus to maintain the high vital temperatures of ancient times. Here we have man, apes, rodents, carnivores, artiodactyls (the even-toed ungulates) and birds, with body-temperatures ranging from 37·5° to 43°.

It must be remembered that many animals do not possess any defenses against the winter temperatures of temperate regions, as is seen by the relatively few active insects to be met with in that part of the year. The survival of most animals through the cold season is accomplished by a passive stage of existence, such as the egg, or the pupa, protected by enclosing membranes; or by the animal itself burrowing deeply into the earth, or into logs: or by migrating into deeper and usually warmer water, or to the vicinity of springs; or by concealing themselves in sheltered crevices, in caves, or under stones. Yet we must be careful in asserting too freely that animals perish in consequence of ordinary winter temperature. In such apparent cases it may be that scarcity of food is the immediate cause of death.

A direct protection against low temperature is afforded by increased thickness of the hair, fur, or feathers with which the exterior of the body is covered. Instances are seen by comparing the living Indian and African elephants, inhabiting warm regions, and whose hairs are short, few and dry, with the extinct mammoth, an inhabitant of cold climates, and which possessed a thick, woolly fur; yet the mammoth belongs to the same genus as the elephants. The Arabian horses have short, shiny hair, while those of Norway and Iceland have thick and tufted fleece. So, also, horses and many other mammals inhabiting temperate zones acquire a much thicker fur in winter, and shed it again on the approach of summer. Similar changes in the thickness of the plumage has been noted in the grouse, and Mr. W. Stone has pointed out to me the greater thickness of the winter plumage, especially on the feet, of the Ptarmigan.

2. Water is a prime necessity to active life. The great majority of animals are utterly helpless in its complete absence for any considerable length of time. Such helplessness extends, also, to their eggs; so that the continuance of the species depends on the constant presence of at least a certain amount of moisture. There are, however, numerous animals living in shallow pools or streams which regularly become dry during some portions of each year. The preservation of such animals from year to year is accomplished either by special habits of the adult, enabling it to safely pass through the dry season, or by the structure of the eggs by which they retain their powers of development unimpaired even though dried and baked in the mud bottom of the pond, or water course.

Thus, especially in the tropics, many fishes of different groups embedded in mud, survive the dry season. The most famous case is probably that of Protopterus, the mud-fish of many African rivers, which excavates a cavity for itself in the mud, coats it internally with a layer of mucus, which hardens and renders the chamber more or less water-tight; and within this spends the dry season, breathing air, since this is one of those fishes which possess functional lungs as well as gills. Instances are also recorded of terrestrial mollusks burying themselves in the ground in South America during the dry season, while others prevent loss of moisture by secreting mucus which forms a hardened plug, closing completely the aperture of their shell.

It is interesting to mention here a case of perhaps similar kind to those just referred to, since the fish now in question lives in this neighborhood, and may possibly possess some similar means of prolonging its existence when the ponds in which it lives are dried up. Mr. C. A. Brinley states: In a closed jar of a capacity of about 1 gallon, containing well water and aquatic plants which grew well, "various fish were placed from time to time; but all without exception died in less than six hours except a mud minnow (Umbra pygmæa). This came to the top at frequent intervals, on each occasion emitting bubbles of air and presumably gulping more down, making considerable noise in so doing. On being placed in well aerated water, six weeks or more later, this habit ceased. I have never found any of these fish dead in dried up pools, though I have carefully looked for them. Presumably their ability to use air for respiration saves them." On the page of The American Naturalist preceding the record of this observation, Prof. Cope has a note on the finding of this species and two others in a thoroughly isolated pool, only 25 feet in diameter and 3 feet deep, near Winslow, Camden County, New Jersey, in September, 1896; and he adds that the pool was said to have been dried up during the summer then just passed. It may be that observations yet to be made upon this fish will prove the correctness of Mr. Brinley's suggestion, coupled with some power of living in the mud during the dry period, or, perhaps, with some other yet more interesting habit.

A striking case of yearly preservation of animals by resistant eggs dried in the mud has recently been published by Mr. E. Atkinson. In May, 1858, observing that the Upper Pool of Gihon, outside the Jaffa gate of Jerusalem, had all its water drained off, he carefully took up several pieces of mud which had formed the bottom of the pool and had cracked in drying. He noticed shells of dead Entomostraca (small crustaceans) in this mud, and determined to learn whether their eggs survived in it. Some of this mud, sent to England, came into the hands of Dr. Baird, of the British Museum. When it was moistened, various individual Entomostraca appeared in the water, having developed from the eggs laid by parents in the Pool of Gihon when it was filled with water. Six different species, belonging to five different genera, were thus reared and described by Baird. Mr. Denny, of Leeds, who also had some of the mud, decanted the water which had been used to moisten it in the summer of 1859, and the mud was again dried without being disturbed. Left dry until the following spring (1860), the jar containing it was again moistened. Most, if not all, of the species found the previous year reappeared. So the experiment was repeated year after year until 1866, most of the species living for two months, several for three months or more, then depositing their eggs and dying. The ova, however, retained their vitality in the dry mud so as to give rise to other individuals on the following addition of water. Another piece of the original mud of 1858, received by another person, who kept it dry for nine years, when moistened was found, a fortnight later, to have yielded a living, single specimen of one of the species described by Baird. Still another recipient of the mud, after alternately wetting and drying it for twenty-four years with unfailing success, accidentally lost it, but discovered it again after a severe winter, during which the globe containing it had frequently been buried in snow. Yet in the spring, transferred to another globe and moistened, the mud yielded its usual crop of Jerusalem Entomostraca. After 1884, some of this latter mud remained dry for ten years; but in 1894 moistening produced the same result as in the preceding experiments.

In some animals the same means employed as a defense against changes in temperature may also act as a defense against loss of moisture. Such are the statoblasts of the Bryozoa. The Bryozoa are minute animals, found in fresh water and in salt, having a branched form; so that they would suggest plants to one unacquainted with them, and have received the popular names of sea mosses and moss animals. In those Bryozoa which live in fresh water, many species have the power of producing certain structures, not eggs in the true sense, but yet which serve the same purpose as eggs and which are known as statoblasts. They contain living protoplasm in their interior capable of developing into forms like their parents, and are provided with thick walls, which serve to protect that protoplasm from the effects of temperature and moisture in the way which is now to be described.

The Danish investigator, Wesenberg-Lund, has made the most recent prolonged studies on the habits of this group of animals. As the result of five years of study of the fresh water Bryozoa of Denmark, he says of the functions of statoblasts that, first, they preserve the species against the effect of frost and cold in the temperate climes, and against heat and desiccation in the tropics; in the second place, they distribute the species over a greater area, being carried by currents of water. Statoblasts "germinate" at temperatures between 30° and 10° Centigrade; but their germination is not accelerated by heat at will of the experimenter. Thus, he kept statoblasts from September to May at 20° Centigrade without succeeding in germinating them. He believes, therefore, that a period of repose must intervene before a statoblast is in condition to germinate; and the necessity for this, he believes, is that otherwise a sudden elevation of temperature in the autumn would cause germination, and the new colony thus started would soon perish in the succeeding winter's cold. The statoblasts retain their powers of germination for at least fourteen months. Thus, he placed those of Cristatella in the refrigerator of a laboratory August 25, 1895; left them there until November 1, 1896, when they were exposed to the ordinary temperature of the laboratory itself, and, finally, placed in a thermostat at 23° Centigrade. At the end of eight to sixteen days, more than eighty statoblasts germinated.

3. As the winds are climatic factors affecting the life of terrestrial and aerial animals, so waves and currents must be considered as climatic factors acting upon marine and fresh-water species. Such waves and currents may injure animals by battering them against rocks, or by overwhelming them with sediment. Mr. A. R. Hunt classified these affects according to the depth and character of the sea bottom on which animals live. It must be premised that he found "no lack of evidence that the power of strong currents at a depth of 40 fathoms is occasionally considerable; that it is by no means exhausted at that depth; and that on occasional disturbances of a sandy bottom the depth of 50 fathoms may be attained, or even exceeded." He groups the marine fauna exposed to the action of waves into: first, animals living on tidal strands, and, second, animals living at the sea bottom outside tide marks. The tidal strand animals may live upon a rocky bottom or other firm foundation, or in sand or other incoherent deposit. Living upon firm bottoms are such animals as permanently attach themselves thereto, such as, oysters, barnacles and mussels, the attachment being made by a calcareous secretion, as in the first and second instances named, or by certain threads which project from near the hinge of the mussel, and whose other ends are either fastened to other mussels of the cluster, or to firm objects in the water itself. Other animals living under these conditions possess the power of temporary attachment, as the sea anemones, or by means of a muscular foot, as in the group of limpets, where also the low, somewhat conical form of the shell is such as not to give the waves any hold which would tend to dislodge the animal from its position; while the foot which acts as a sucker is completely, or almost completely, covered by the shell. Still others obtain firm attachment, or firm lodgment, by boring into rock, as do Petricola and Pholas among bivalves. Tidal strand animals living on sand, or similar shifting material, save themselves by penetrating more deeply to avoid being washed away and battered by the waves; or, if they are temporarily covered by a wave's load of sand, can force themselves up so quickly as to avoid being smothered. The azor shells are delving animals of this kind.

To those animals living on a rocky sea bottom outside of tide marks, or, rather, below low tide mark, protection is afforded by the same means as exist on the tidal strand; but when the bottom is sand or mud, its inhabitants either burrow up through the freshly deposited sediment, as just mentioned, or else are provided with spines which moor the possessor in place and prevent dislodgment by the waves, as in certain species of cockles (Cardium aculeatum). Other Mollusks have broad, flat processes on their shells, or numerous spines, which are of great use in righting the animal after having been upset by a current (Aporrhais Pteroceras, etc.). Of the cockles, Cardium aculeatum and C. tuberculatum, the former has very long spines, and the latter has them quite rudimentary. These two species do not apparently thrive together, when their shells are perfect, in the same deposit at Torbay (England), though their habitats are not far apart, the one being soft and muddy sand (that is, aculeatum, provided with long spines), the other (a non-spinous form) pure and firm sand. There can be little doubt that a radical change in the character of the two deposits in which these species respectively live would cause their local extinction by making it impossible for them to offer a successful resistance to their enemies, the wave currents. Hunt, whom we still quote, "found specimens of C. aculeatum that had been washed in from sea and their spines, denuded in the process, living side by side in the hard ground with C. tuberculatum. A very slight advantage from form or sculpture might be of great importance in saving the cockles from local extinction; for, in the case of Torbay, the struggle for existence is so severe that both species are occasionally washed on shore in sufficient quantities to be carted away for manure."

4. Irrespective of the action of waves and currents, sediment may be a source of danger to animals. Among those whose lives are spent in contact with sediment are many crabs, which make temporary excavations in which they are more or less embedded. Since the respiration of these crabs is accomplished by the flowing of a constant stream of water over their gills, it is quite evident that the entrance of particles of sand, mud or gravel into the gill chambers would soon interfere with respiratory processes. In order that such interference may not occur, defenses exist in the form of sieves to keep out the sediment. Garstang states that when the crab (Bathynectes longipes), of the English coast, is partially embedded in the sand, it may be noticed that the chelipeds (great claws) are flexed and approximated to the under side of the antero-lateral regions of the carapace, or upper shell. The position of the cheliped is such that the marginal teeth of the carapace exactly overhang the slit-like orifice between the cheliped and the carapace itself. The teeth convert this slit into a sort of comb-like sieve. By coloring the water with India ink, he found that the currents which are used for breathing pass down between the claw and the front edge of the carapace, but that grains of sand which may be present are held back—so to speak, stopped—by the teeth; so that the water which passes below is free from them.

In a crab of the Mediterranean, Calappa granulata, which likewise has the habit of living in sandy places, the front edge of the carapace is perfectly straight, but to make up for this lack teeth are situated on the edge of the claw, so that when the claw is similarly brought against the front edge of the shell, a similar sieve-like arrangement results. Experiments have not, it is true, been made with this species, but the suggestion is evident.

In other crabs quite different means are employed for the same end. The British marked crab burrows in fine sand, but not in that of a coarse gravelly character, and so completely that its body is entirely covered, except for the tips of its very long second antennæ. Each of these antennæ is fringed on each of two edges, for its entire length, with hairs, directed toward the antenna of the other side of the body. The two antennæ are placed together, the hairs of the one interlock with the hairs of the other, so that a temporary tube is formed. By similarly coloring the water with India ink, Garstang found that currents of water are drawn up and down through this tube in the process of breathing. In this way the animal obtains its supply of water unmixed with sediment. Singularly, in the British species just described, it is the second pair of antennæ which are thus modified; while in an Indian crab, belonging to another genus, but having the same habit, it is the first pair of antennæ which show the same peculiarity.

One of the most common defenses against waves, current and sediment, possessed by marine animals, is the possession of a stalk, or base, which holds them fast to some fixed support and at the same time lifts them above the débris constantly accumulating on the sea bottom. To cite only a single illustration, the beautiful glass sponges are firmly fastened by long, siliceous, fiber-like spicules to muddy bottoms, so that the living parts of the animal are held above the sediment. In that known as Hyalonema, the stalk may be as much as 65 cm. (26 inches) in length, while the body of the sponge is but 15 cm. (6 inches) long.

When such a stalk is flexible, its advantages are likely to be greater in enabling the animal to more readily shake off sediment falling upon it, and, perhaps, also to escape the force of powerful currents in floating to and fro with the water, as Lang suggests. Animals possessing flexible stalks are various Protozoa, Crinoids, and Tunicates.

### CONCLUDING REMARKS.

In bringing this course of lectures to a close, it will be well to summarize the chief topics dealt with. We have given a wide meaning to the term "Means of Defense," so as to include all those methods by which animals attempt, successfully or unsuccessfully, to struggle against the adversities of life. A consideration of the struggle for existence and of the rates of mortality has enabled us to classify the causes of that struggle and of that mortality as the rate of increase and consequent competition, the limitations of the food supply, and of climate, and the reciprocal relations due to carnivorous habits. Each of these factors differs greatly in value in its effect on different species of animals. Corresponding to these factors, we have considered the defenses of animals according to the protection which they afford to the young, to the food supply, against living enemies and against climatic changes.

Under each of these four captions we have mentioned a considerable variety of means of defense, and especially when treating of the protection of the young, we have sought to obtain some idea of the effect upon the struggle for existence which is due to the different means of defense possessed by the egg, the young and the adult of the same species. Those who have listened to these lectures cannot have failed to notice how briefly and superficially these topics have been treated. This brevity is the best evidence of the great extent, and, we may also add, of the complexity of the subject. Doubtless, also, much as we have tried to at least mention the classes of methods of defense, we have omitted some of them.

We began with the struggle for existence and the rate of mortality; we have spent most of our time on the means of defense, and now we must return to mortality again. For, in spite of the protection secured by animals in manifold ways recounted, ways which so often call forth our wonder and admiration, it is our

duty to recognize that many of these means of defense are inadequate and have failed. The consequences of failure have been the extinction of species. Such extinction has taken place throughout all rock-recorded time and long previous to the appearance of man with his weapons on the scene, as, perhaps, the greatest destroyer of them all. Such extinction is most noteworthy in groups which have left absolutely no descendants within recent geological times, such as the gigantic mammals of the Eocene and Miocene, the Dinocerata, Coryphodon, and Brontotherium.

We may also select an illustration of the at least partial failure of a means of defense from among living insects. We have referred in our fourth lecture to commensalism (Messmateism) as beneficial and protective to those animals practicing it. The staphylinid beetles of the genera Atemeles and Lomechusa are never found out of, or very far from, ants' nests. The ants lick the beetles, apparently to obtain a substance secreted by certain hairy patches on the beetles' bodies. Both ants and beetles disgorge their own food for the other's benefit. The young of the beetles are reared by the ants along with their own offspring, but here the disadvantage enters. When the young ants are in the pupal stage the old ants dig them out of the earth from time to time and clean them. They do the same to the beetle larvæ. But this treatment, beneficial to the ant-pupæ, is fatal to the larval beetles, and of the latter it seems that only such as are forgotten by the ants reach the adult condition. Rates of mortality among the beetle larvæ of from 96·71 per cent. to 100 per cent. have been recorded from this cause. (Wassman, quoted by Sharp.)

Prof. Cuénot, whom we have already quoted at some length in the preceding lecture, rightly suggests that the reasons why so many animals die in spite of their means of defense are as follows:

(a) The means of defense are not equally efficacious against all possible enemies. For example, frogs and toads swallow, without the least inconvenience, the blister-beetles, in spite of the apparent death of these beetles, and of their containing cantharidine, which is very poisonous to other insects, to lizards and to mammals. Frogs and sparrows swallow bees in spite of their stings.

(b) Means of defense ordinarily sufficient, are not so, at times, against a robust or a very hungry assailant. Thus, the examination of the contents of the digestive canal of wild lizards often shows foods which are almost always refused by lizards kept in captivity.

(c) There are moments in life when the means of defense function badly, or not at all. So it is when armored animals, such as the crabs, moult; inability to produce the protective secretion at times when the individual is fatigued, badly nourished or aged; or moving away from the background to which animals are similarly colored.

Cuénot closes with a warning as to the necessity of control experiments, since the views which exist as to the protective defenses of animals are, in a great measure, based simply on theory, and not on actual observation. Thus, particularly with regard to protection which has been supposed to be afforded by the coloring, he says that "it does not necessarily follow that each little peculiarity of a species should necessarily have some significance, or some value, in its struggle for existence. There is no reason why the particular design on the shell of a mollusk, or on the wing of an insect, should have any usefulness, or any utility whatsoever for its possessor. Animals have, perhaps, many organs which may either be useless or which function sometimes rather better than ill; at other times, rather ill than better. Besides, we are often apt to judge of the means of defense of animals from the human standpoint without thinking that animals may, perhaps, have appreciations and sensations absolutely different from our own."

In thanking you for the attention which you have given me, I hope that these lectures have fulfilled at least two ends: first, to bring to your notice new facts concerning the life of animals, or old facts in new relations; and, second, to suggest by these facts how complex the struggle for existence is; how many factors determine success or failure in that struggle; but, above all, how little we really know of those factors. If knowledge of ignorance leads to personal study of living nature, and this, in turn, to a fuller realization of life, both you and I will justify the hearing and the giving of this course of lectures.

## RUSSIAN CENTRAL ASIA: COUNTRIES AND PEOPLES.

By ARCHIBALD R. COLQUHOUN.

No attempt is made, in the following paper, to deal with the political problems which arise from the presence of the Russians in Central Asia, a territory hitherto abandoned to the many tribes and peoples, some wild and uncivilized, who have inhabited the land for generations. Many of these native States were rich and prosperous, and, although Oriental, highly organized; others were mere congeries of nomad families: all present features of great interest and novelty. Of the steady progress of Russia, east and southward, I have spoken elsewhere. I propose to-night to give a brief account of some of the people she has encountered in this progress and the countries which have come under her flag during the last half century. The variety of races, the differing conditions both of climate and geography which are found in these countries and peoples are not only interesting in themselves, but when we reflect that they are already practically consolidated into well-organized Russian provinces, afford an excellent illustration of the tenacity of purpose characteristic of the Slav race, and also of their power of assimilation. Their success in this direction must be largely attributed to the fact that they are themselves partly Oriental, and so akin to the people they have conquered.

The territory described as Central Asia is bounded by Siberia on the north, by the Chinese Empire on the east and southeast, Afghanistan and Persia on the south, and on the west by the Caspian Sea and European Russia. It originally consisted of three kingdoms, known as the Central Asian Khanatés of Bokhara, Khokand, and Khiva, of the Khirgiz Steppes, the half desert country of the Tekkés, the oasis of Merv, and the districts of Kuldja, Ferghana, Zaraf-shan, and the Pamirs. These are now, roughly speaking, divided into the provinces of Orenburgh in the north (including a large slice of Siberia), Turkestan and East Turkestan, central and east, and Transcaspia on the west. Bokhara retains its native ruler and form of government, but is under Russian suzerainty.

The climate of Central Asia varies considerably from north to south, and may be roughly divided into three zones. The northern zone extends as far south as latitude 45°, and includes the lower course of the Syr Daria to Fort No. 2, and the lower course of the Ili. The climate in this zone is what is known as "continental," with very hot summers and very cold winters. Snow remains on the ground for about three months, while the summer is extremely hot, and lasts from four to five months. The central zone includes the towns of Perovsky, Turkestan, Aulieata, and Vierny, with the middle course of the Syr Daria and a large portion of the Kyzyl Kum sands. Here the winter may be compared to that of Central Germany, while at Vierny grapes ripen, though not so well as further south. The southern zone is tropical, and includes Kuldja, besides those towns which lie either in the same latitude or south of Tashkent. Kuldja owes its comparatively high temperature to its sheltered position, being surrounded by high mountains, which protect it from the north-easterly winds, so prevalent in the rest of the central zone. Fruits of a delicate nature flourish—peaches, apricots, pomegranates, and grapes. The winter, though cold, is short, snow seldom remaining on the ground for longer than a month. There is, however, a great deal of rain; the rainy season lasts from about March till October.

The district of Hodjent, acquired by Russia in 1874, lies south of Tashkent, and with the valley of Zaraf-shan is the most fertile part of Central Asia, and was for some time a disputed point between Bokhara and Khokand. The country here is better wooded than most parts of Central Asia, and also better watered; everywhere one sees the beautiful gardens which are the joy and pride of all dwellers in Central Asian towns. These gardens surround most of the cities, and are often used as summer residences, the Russians even having adopted the fashion, and camping out in roomy tents and pavilions during the hot months. Peach, cherry, and apple trees make these gardens beautiful, and it is much to be regretted that, owing to the scarcity of coal, these orchards are being largely cut down for fuel.

With regard to mineral produce, the lack of good coal in Central Asia is likely to prove a serious drawback to its development, although the improvement in communications will largely remedy the defect. Since the acquisition of Turkestan, the government have made great efforts to discover really productive coal beds; but although coal exists scattered pretty widely over Central Asia, all that has been obtained hitherto is of inferior quality, and broken up into small fields. As for other minerals, it is curious, considering the trifling amount of gold found in this part of Russia's new possessions, to remember that her first step toward Asia was initiated by Peter the Great because he had heard so much of the gold to be found on the banks of the Oxus. Lead-ore is the most abundant mineral, but this cannot be mined with any great profit on account of the dearness of fuel and difficulty of transport.

There are several different races inhabiting Central Asia, but, broadly speaking, they are all of Persian or Turkish descent. A part of the country was undoubtedly inhabited in early times by the Sacæ, or Scythians, an Aryan race who were, to a large extent, dispossessed and driven out by the Turkish tribes who overran the country. The descendants of this ancient race are still found in considerable numbers, often clustered together in mountain villages, to which they have been gradually driven by the succeeding waves of Russian invasion. A curious testimony to the antiquity of the race is the fact that their language retains many words of Aryan derivation which are not known in modern Persian. The Tadjiks, as they are called, are distinguished, not only in appearance, but in character, from the tribes of Turkish descent. The typical Tadjik is large, thickly bearded, vain with the childish vanity common in primitive races, lazy, untruthful, and morally corrupt. He despises his less subtle Uzbek neighbor, who returns the sentiment, but is nevertheless compelled to make use of the sharper wit of the Tadjik. The Uzbeks, who form a large proportion of the population in Central Asia, are a tribe, or congeries of tribes, of much the same origin as the Kirghiz, being founded by Turkish immigrants who flocked into the country both before and after the time of Genghiz Khan. Unlike the Kirghiz, however, the Uzbeks have little of the Mongol element. They speak a Turkic dialect, and retain, at all events traditionally, their old division into clans or families, the names of which in some cases perpetuate long-forgotten tribes. One clan is that of the Kiptchaks, whose martial habits and traditions made them a chief factor in the army of Khokand. The most numerous race, in the western part of Central Asia at all events, is the Kirghiz, also perhaps the most interesting.

This tribe really consists of two distinct races. The true one, the Kara or "Black Kirghiz," is found principally in the valleys of the Thian-Shan and Altai Mountains, and is unmistakably of Turkish origin. Descriptions found in Chinese writings of a very early date show that at that time the prevailing type was characterized by light hair and fair skin, which would not apply to the average Kirghiz of the present day, although such may still be met with here and there.

The other race, which inhabits the greater part of the province of Turkestan and the steppes bordering it, called by the Russians "Kassak-Kirghiz," is more impregnated with the Mongol element than the Kara-Kirghiz. They have largely intermarried with the Kalmuks, and their aristocracy, or "white bones," claim descent from Genghiz Khan, while their various traditions describe them as being descended from a "red-haired dog," or (a more poetical story) as veritable "Children of the Mist." Both legends suggest the great antiquity of the race, as is usual with aboriginal tribes of undoubted prehistoric origin, both in America and Australia. The claim of descent from an animal is found with other Asiatic tribes, and is always supposed to denote considerable age.

Although he has now lost his independence, the Kirghiz still retains many curious and characteristic traits, one of these being an incurable contempt for a settled or town life. "Sart," the term applied to merchants and townsfolk, is used contemptuously, and would be much resented by a true Kirghiz, who has a scoffing proverb to the effect that "when a Sart becomes rich he builds a house, a Kirghiz buys more wives." When on the move they live in kibitkas, or field tents, stretched on light wooden frames, and resembling the Mongolian yourtas. These kibitkas are exceedingly portable, and can be packed for a journey in less than an hour. The Kirghiz, as a rule, are of swarthy complexion, and are short and sturdy in build, the men shaving the head, but allowing the beard to grow, while the women wind yards of cotton stuff about their heads. The male attire consists usually of a pair of baggy leather breeches, a coarse shirt, and one or more rough coats, the head being covered with a skull cap and a conical hood of sheepskin or felt. On special occasions a red velvet coat and a tall felt hat, with turned up brim, are worn by the well-to-do. Polygamy was adopted by the race at the time when the Russians forced Mohammedanism upon them, and the position of their women folk is not enviable. When a man wishes to marry he buys a wife, or one is bought for him by his relations, and once the kalym, or purchase money, is paid, the wife becomes the mere chattel of her husband, who generally treats her with less consideration than he does his cattle. He can divorce her with the greatest ease, and her family may then attempt to sell her again. However much she may be ill-treated she has no redress, the utmost that can happen being a remonstrance from her relations to the husband for "depreciating her market value"; while even if he killed her, under Kirghiz law he had no more serious penalty to encounter than a fine. "A woman has only half as much soul as a man," says a Kirghiz proverb; and the men of the tribe evidently act up to this belief. The more serious crimes are now amenable to Russian law, but smaller matters are settled before certain chosen elders, who are not paid for their services, but receive a portion of every fine they inflict. Hitherto little has been done by Russia to civilize the tribes under her dominion, and such a thing as a Kirghiz school is practically unknown. Although Mohammedanism is nominally their religion, the Kirghiz do not trouble much about doctrine, many of them still adhering to the old Shaman, or devil-worship, while ancestor-worship is still largely practised.

It may be said, perhaps, that the principal object of Kirghiz existence is the breeding of cattle and horses, to which nearly the whole of their time is devoted. In bartering his cattle the Kirghiz does not make a feature of honesty, and will invariably cheat whenever he gets the chance.

Fond as he is of horseflesh, his sheep—of which he has a famous fat-tailed breed called the Kurdiak—are perhaps nearest to the heart of the Kirghiz. All over Central Asia and in Southern Siberia mutton is the staple food, and the nomads who inhabit the steppe regions are accustomed to eat it in tremendous quantities. The allowance for a Mongol driver of a caravan, for instance, is a leg of mutton per man per day; but it must be added that should meat fail, the Mongol is not only capable of foregoing his favorite food, but of existing on fare so coarse and scanty that no European could support life on it. The nomads, as a rule, do not take much trouble over the preparation of their food, boiling it in a pot, and taking it out in handfuls as it seems to them sufficiently cooked, or gnawing the flesh from the bones, which they return to the pot again. A very delicate dish, and one set before honored guests, is composed of the tails of sheep; and the shin-bone of this useful animal is carried by superstitious Kirghiz as an amulet, and is also used in divination. His sheep are, indeed, so important to the Kirghiz or Uzbek, or to any native of Central Asia, that it is etiquette to suppose, for the sake of courtesy, that every man possesses flocks, and in greeting him the first inquiry must be not for his health but for theirs.

The favorite drink of the Kirghiz is made from brick-tea, but kumis, or mares' milk, is drunk, as among the Mongols, to produce intoxication, for which purpose also is used a kind of beer, distilled from grain, called buza, which has a stupefying effect.

On the whole, the Kirghiz are a simple and credulous people, not particularly brave. Owing to their skill as trackers, in which they rival the red Indians, they make excellent scouts.

The Kalmuks, with whom, as has been said, the Kirghiz have largely intermarried, are another race of Central Asian nomads, who originated in a confederacy of Mongol tribes living in Zungaria, on the north-western borders of the Chinese Empire, and combining together to resist the aggressions of another tribe of kindred origin. This confederacy, known as the Oirat, made attacks on China, and at one time took the Emperor prisoner, and marched to the walls of Peking. Internal dissensions, however, broke the power of the Oirat, and some of the tribes migrated to Siberia, probably receiving at that time the name of "Kalmuk," which in Turkic dialect means "remnant." Zungaria still remained in the possession of the same tribes, whose fratricidal wars and quarrels finally ended in their becoming vassals to China. Meanwhile, the Kalmuks had been driven further and further, till finally they crossed the Ural, and settled in the lower region of the Volga. Finding her new subjects in Zungaria inclined to rebel, China took a short way of quieting them by a wholesale massacre, and as the country was left desolate toward the middle of the eighteenth century, military colonies of Manchus were formed and Chinese criminals sent, while large numbers of agriculturists were deported from Eastern Turkestan. The last named became known as tarantchis, and occupied a position analogous to that of Russian crown peasants. Although Mohammedans, they lived among their Buddhist neighbors quite amicably, and the only difference made by the preponderance of the Chinese element was in the unveiling of their women. Another element was added in 1771, when the Kalmuks, hearing that their mother-country had been depopulated, returned en masse, taking eight months on the journey, and suffering much both from want and the attacks of the Kirghiz. When they arrived they found the country occupied by the Chinese, and having no alternative, except to fall into the hands of the Kirghiz or Rus-

sians, they settled down on the pasture lands, became subject to the Chinese, and devoted themselves to the breeding of cattle and horses. The Kalmuks are all Buddhists, and are completely Mongolian in type and customs. This district, known from the name of the Manchu settlement which dominated it as Kuldja, was annexed by Russia, but returned to China on her fulfilling certain conditions.

On the western side of Central Asia there are many different families or tribes of Turkomans, who are somewhat similar in habits to the Kirghiz, although some, like the Tekkés, live partly in villages and are agriculturists. No race offered more stubborn resistance to the Russians than the Tekkés, and none suffered more. In the Turkoman campaigns orders were given to spare neither age nor sex, and whole families were slaughtered and entire districts laid waste.

In most of the cities of Central Asia, besides these, are found many fragments of other races—Persians, originally brought as slaves; Arabs, believed by some to have been the original introducers of Mohammedanism; Hebrews, who have been settled in the country for centuries, and who have the characteristics for which their race is remarkable all over the world; Hindoos, who come and go for commercial purposes; and also many families of gypsies, known usually at Liuli, who lead a nomad life, trading in horses, while their women tell fortunes, cure the sick, and carry on a small traffic.

Theoretically nearly all the native peoples of Central Asia profess Mohammedanism, but many of the tribes know little more of it than the name of the prophet, and some not even that. The nomads retain many practices which have no connection with Islam, and it is only in the large cities that there is any attempt at ceremonial worship. Great religious laxity prevails all over Central Asia, and the fanaticism observable among the Dervishes, who gain a living by exhibiting themselves in a religious frenzy, and even torturing themselves at times, is rather a matter of business than of true devotion

Education among the native inhabitants is in the hands of the mullahs or priests, and is generally limited to such matters as have a bearing on religion or law. The foundation of colleges, where the higher religion and law are taught, has for ages been a favorite form of piety, and some still exist which were founded four and five hundred years ago. Both pupils and professors are supported from the revenues of the college, the latter receiving in addition voluntary gifts from parents of the pupils. There are also primary schools, generally attached to each mosque, and here the boys from the age of five are instructed first in the alphabet, and then in the reading of the Koran and about seven other books, which they read and copy without understanding, as they are written in Persian and Turki, and never translated into the dialect of the district. To know the Koran by heart confers at once rank and sanctity on the happy accomplisher of that feat. This is usually an effort entirely of memory, as few are acquainted with Arabic, though many have read illegal translations and know the substance of what they recite. Superstition is extremely rife, especially among the nomad tribes, who attach mystic meaning to such events as the appearance of crows (as in Western Europe), magpies, and other birds and beasts. A favorite method of divination is by roasting the shin bone of a sheep and watching its appearance as it burns, from which the future is predicted by certain signs.

As regards religion, the Russians have always acted with the greatest wisdom and tolerance, never in any way interfering with the worship and practice of the conquered tribes, except that they have abolished the native functionaries whose business was to compel the performance of religious rites. Missionary projects have been by no means encouraged, although in the garrisons and in one or two towns there are Christian churches, and a Bishop of the province of Turkestan. The Russians have acted with less wisdom in arranging the administration of their new provinces; and, in trying to force upon the natives systems foreign to their customs and characters, they have earned a certain amount of unpopularity. One instance is the method of local government by natives elected by vote, under the surveillance of the Russian government. This, with modifications, has been tried among Kirghiz, Uzbeks, and in the chief towns. The people left to themselves would always elect men of influence and popularity—their former leaders—who, for obvious reasons, are not acceptable to the Russians, so that the system has degenerated into mere farce, and is viewed with contempt by the natives, the men chosen being merely the tools of the Government.

The advent of the Russians in Central Asia has naturally made a great difference in many of the towns which, originally entirely Oriental in character and appearance, now present the curious contrast of European streets and squares, occupied by officials and their families in the unpicturesque garb of the Western world, side by side with the native towns, old, in some cases, with an age which makes such cities as York mere infants; trodden by countless generations of conquerors—Macedonians, Scythians, Arabs, Persians, Mongols; and which have succumbed—is it for ever?—to a greater than these, a race from the West.

The farther one penetrates into the heart of Asia the less has this modernizing influence made itself felt; so that between Orenburg, which is really on the borders of civilization, and Samarkand there is a wide gulf.

Perhaps one of the most typical towns under the new régime is Tashkent, the capital of the province of Turkestan and a city of very ancient origin. Mention is made in the 7th century by a Chinese traveler of a city, either on the same spot, or near the site of the present one.

Briefly, its history up to a certain point is the story of the struggle between the two sovereigns of Bokhara and Samarkand, and when both were subdued by the Tartar chief, Genghiz Khan, it remained in the possession of his descendants until reconquered by a Khan who ruled over both Bokhara and Samarkand. Then came the Kirghiz, who held it for more than a hundred years, till it fell before an enterprising ruler of Zingaria, and after a short time achieved a semi-independence, being alternately overlorded by Khokand and Bokhara. It was in the struggle with Khokand that General Tchernaieff, fearing that Tashkent would fall into the hands of the hostile Amir of Bokhara, to whom the inhabitants—between Scylla and Charybds—had appealed for help, invested the city with a comparatively small army, and being fortunate enough to kill the Regent of Khokand in the first engagement and to cut off the water supply of the city, entered by two gates simultaneously, chased the Khokandians and Bokharans out of the city, and received the unconditional surrender of the natives. The Russian rule was firmly established, and order maintained by native police, who still seem to work well under their new masters.

(To be continued.)

## ARCHÆOLOGY OF LYTTON, BRITISH COLUMBIA.

By HARLAN I. SMITH.

Lytton is situated at the confluence of the Thompson and Fraser Rivers, in southern British Columbia. Below Lytton the Fraser River breaks through the Coast Range, forming a deep cañon, while above Lytton it flows through the plateau, which extends from the Coast Range to the western range of the Rocky Mountains. The climate of this area is rather dry, and consequently the vegetation is somewhat scanty. The higher parts of the country are covered with open timber. The Indians inhabiting this area at the present time subsist largely on fish, of which there is an abundant supply in the rivers, particularly at the time when the salmon ascend to spawn; but fish is not by any means as important a staple as it is among the tribes of the coast. Roots and berries, which are gathered on the hills, form an important part of the diet of the people, who also hunt deer and bear, on which they subsist when living at a distance from the rivers.

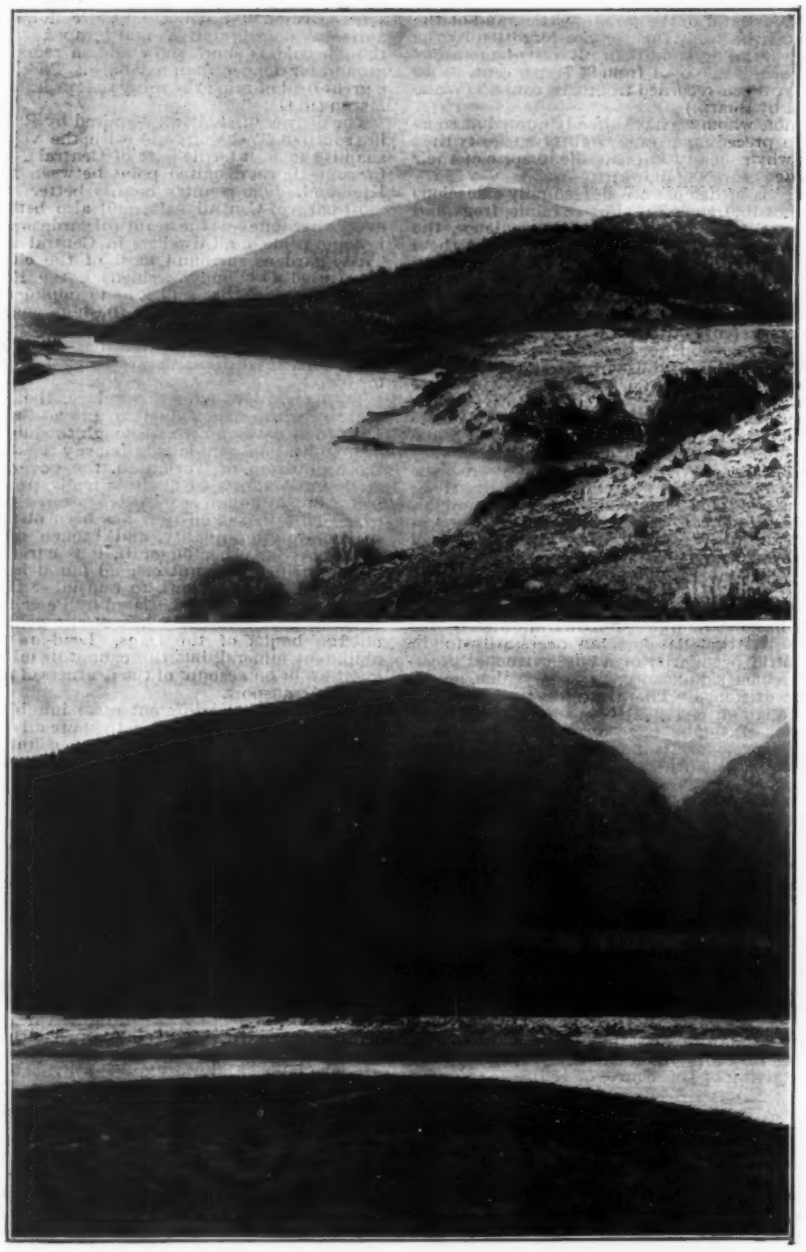
On account of the importance of the fish distance more permanent villages of the Indians are located on the larger rivers, principally on the Fraser and Thompson. Places on the banks of the river which are not too far removed from the berrying and root-digging grounds are the favorite resorts of the Indians. Lytton is most favorably located for all these pursuits, and consequently it has always been an important village. Evidently the same conditions prevailed in prehistoric times, as is shown by the extensive remains and the large burial-grounds found at the place.

A large burial-ground on the point of land between the Fraser and Thompson Rivers has long been known. It was first described by Dr. George M. Dawson, who investigated it while engaged in geological work, in Southern British Columbia duringthe years 1877 and 1888-90. The collections made by Dr. Dawson are in the Museum of the Geological Survey of Canada.

In July, 1897, the Jesup North Pacific Expedition made a series of explorations in this vicinity. The following descriptions are based upon these explorations, which were carried on by the writer.*

The explorations were largely confined to the main burial place and village site, situated on the sand hill that is found along a terrace between the cañons of the Fraser and Thompson Rivers and immediately to the north of their confluence.† This is by far the most important site near Lytton. The hill is about 100 feet above the river, and is approximately 500 feet in length by 200 feet in breadth. A large pine tree is growing on the crest of the hill, in the middle of the burial place. An Indian trail passes to the west of the area, and the government road bounds it on the east. No definite age can be assigned to any of the remains secured, as the wind, which sweeps strongly up the cañon of the Fraser River, is continually shifting the light, dry sand from place to place. It uncovers the graves, disarranges them, and sometimes recovers the remains. Miners and Indians often camp at this site; and the objects left or lost by them are scattered on the surface, and often covered by the shifting sand. All these objects must be distiguished from the undisturbed burial of the prehistoric people. The surface is strewn with human bones which have been uncovered by the wind. There are also scattered about shell beads, wedges made of antler, scrapers and chipped points of stone, such as are used for arrows and knives, grinding-stones, celts, and other material similar to that found in the graves. There is a large box at this place, in which the Indians deposit the bones and objects as they are uncovered by the wind, but sometimes they bury them. The bones they consider to be those of Indians, although they do not know whether they are of their own ancestors or not. It is reasonably certain, judging from the complete absence of European objects in the undisturbed graves, that they antedate contact with the whites. A number of them must be several hundred years old.

Extending to the north from the hill, and on the same terrace, were found old hearths, indicated by broken and cracked firestones, large slabs of grinding-stones, and remains of underground houses. A few human bones were secured from the edge of the gravel



VIEW UP THE FRASER RIVER, NORTH FROM LYTTON, B. C.
VIEW ACROSS THE FRASER RIVER, SHOWING HOUSE PIT IN FOREGROUND.

* Transactions of the Royal Society of Canada, Sect. D, 1891, pp. 10-12.
† See upper view in the frontispiece.

pit made by miners near an Indian cemetery known to be modern by the portions of the fence which still remain.

Southward from the sand hill, on the level of the terrace, were found traces of similar hearths, charcoal, and rolls of birch bark partly burned. Here were also remains of underground houses. There were two large bowlders, which the Indians report were used in the ceremonials performed by young men or by youths when reaching maturity. It is said that these youths were required to cover the distance from one bowlder to the other in a prescribed number of leaps.

About half a mile below Lytton, on the high gravel terrace on the left bank of the Fraser River, was found a second village site.

A third village site was located on the high terrace on the left bank of the Fraser River, about 2 miles north of Lytton. The place is a meadow in an open pine forest east of the government road. South of it is a small brook, ending lower down in a marsh. This may have determined the location of the site, since it affords a supply of fresh water high above the Fraser River.

A fifth ancient village and a burial place were located at the north side of the mouth of Stein Creek, which empties into the Fraser River, from the west at a point about 4 miles above Lytton. This place is on the tableland overlooking the Fraser River, and near the present Indian village of Slame. Here were human bones, fragments of specter shells, fragments of steatite pipes, and wedges of antler, scattered by the wind. On the lower terrace, close to Stein Creek, are remains of ancient houses which measured from 50 to 60 feet in diameter.

Some attention was given to the sixth site, which is marked by burials and traces of habitations on the low sandy terraces on the west bank of the Fraser River, about opposite the main burial place. These sites may or may not have been occupied at the same time.

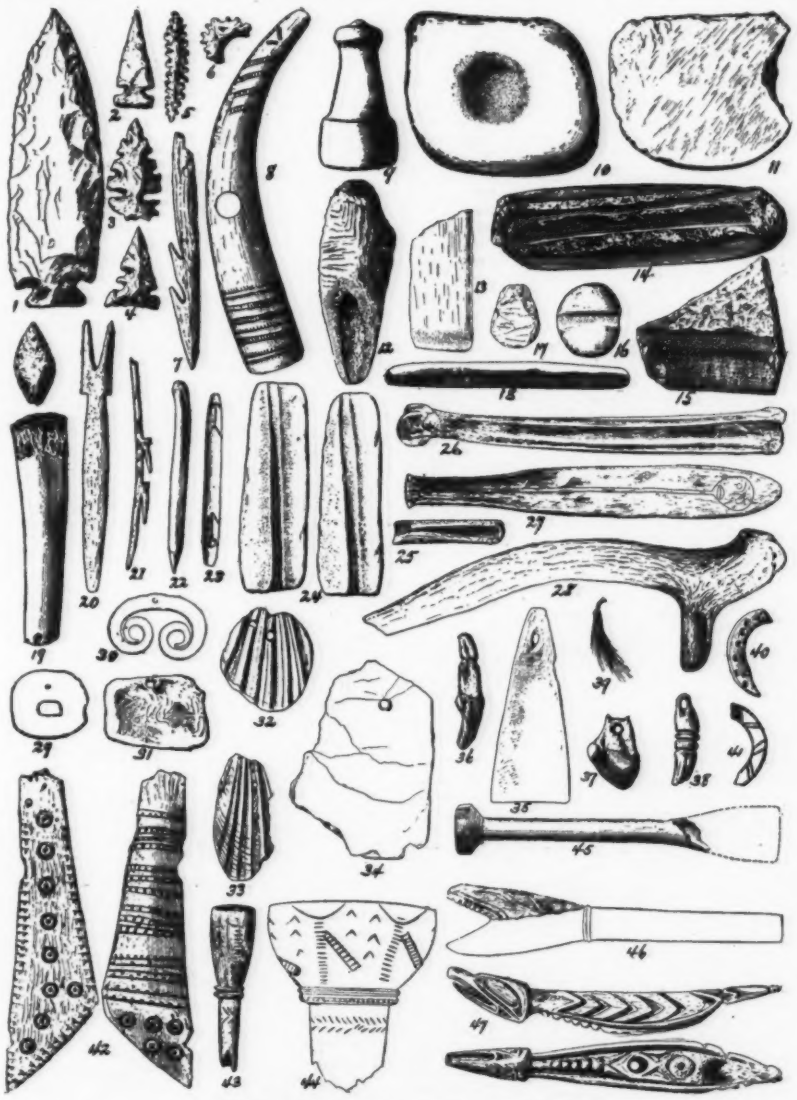
All through this region are evidences of prehistoric habitations, located at varying distances from the larger village sites. This suggests that the mode of life of the prehistoric people was similar to that of the present Indians, among whom one or two families often live at some distance from the main villages.

Resources.—The resources of the prehistoric people of Lytton, as indicated by the specimens found in the graves, hearths, and about the village sites, were chiefly stone, copper, shell, bone, antler, teeth, the skins of animals, and vegetable substances.

Many evidences of the association of animals with man were found. While it may be that some of the animals whose remains are found in the village sites and burial-grounds did not live with the people, having taken up their abodes in these places after they had been deserted, numerous worked and broken bones and teeth show that the animals to whom they belonged must have been useful to the prehistoric inhabitants of Lytton.

The present Indians of this area used dentalium shells, which are not imported along the Fraser River, but from the region north of Vancouver Island, over the mountains, down to the upper course of the Fraser River. The trade in these shells is in the hands of the Chilcotin, an Athapascan tribe of western British Columbia. It is probable that in prehistoric times dentalium shells found their way to Lytton over the same route. It seems at least that the use of dentalium shells was much more extensive in the interior than it was in prehistoric times in the delta of the Fraser River.

Vegetable substances include charred pieces of wood from the hearths, and other charred fragments which had probably been portions of canoes, sticks, etc., that were found in various parts of the village sites. Pieces of wood were found wrapped in copper, and preserved by the action of the copper salts, the whole being probably an ornament of some sort. Birch bark charred, or preserved by the dryness of the climate, was found in the graves as lining or covering, and in the form of rolls. Probably it was also used for dishes. Charred berries, including bearberry, were found in the hearths; and to this day edible roots are plentiful in the vicinity. That they were dug for food is suggested by the presence of the digging stick handles. The seeds of a western species of Lythospermum, which may have been used for food, were frequently found in the hearths; and large numbers of them were sometimes over the skeletons in the graves, as if that plant had been used as a covering of the bodies. A kind of gum that was found in a clam-shell spoon and on a bone handle for a stone knife resembles that from the fir and pine. Woven fabrics of vegetable fiber, possibly sagebrush bark, and portions of string made of the bark of red cedar, were found in the graves.



REPRESENTATIVE ARCHÆOLOGICAL SPECIMENS*

1 Chipped chalcedony point, ¼; 2 chipped basalt point, 2-5; 3, 4, 5 & 6 fantastic chipped basalt forms, ½; 7 antler harpoon point, ⅛; 8 antler handle of digging stick, ¼; 9 stone pestle, ⅛; 10 stone anvil, ⅛; 11 slate fish-knife, ¼; 12 antler wedge, ¼; 13 nephrite celt, ¼; 14 serpentine from which pieces have been cut, ¼; 15 grinding stone, ¼; 16 stone club-head, 1-5; 17 stone skin scraper, ⅛; 18 whetstone, ¼; 19 knife and handle, ⅓; 20 & 21 antler objects, ¼; 22 bone awl, ¼; 23 bone needle, 2-5; 24 pair of grooved stones, ¼; 25 beaver tooth knife, ½; 26 bone skin scraper, ¼; 27 copper war club, from Spuzzum, ⅛; 28 antler war club, 1-5; 29 & 30 copper ornaments, ½; 31 abalone shell object, ¼; 32 & 33 shell objects, ¼; 34 mica pendant, ½; 35 bone pendant, 1- ; 36, 37, & 38 tooth pendants, ½; 39 hair tassel, ½; 40 & 41 dice, ½; 42 antler implement, ½; 43 pipe collected by Dr. Dawson, ⅓; 44 design on 43; 45 & 46 fragments of pipes, ⅜; 47 sculptured antler ⅛. *Fractions indicate reductions.

Hunting and Fishing; Digging Roots.—Many implements used in procuring food were found. By far the most numerous were chipped points of various sizes and shapes for arrows, knives, and spears. The material commonly used for chipped points is glassy basalt. Practically all the smaller implements are made of this material. An unusually large number of fantastic forms of small chipped objects were found here. These are of the same material as the other small points.

It is remarkable that no rubbed stone points for arrows or spears, such as are numerous on the coast, were found, although rubbed fish-knives are quite common, and one rubbed slate point was obtained at Kamloops, 95 miles above Lytton in the Thompson Valley.

The Indians now living in the valley of the Thompson River, near Lytton, still possess the art of chipping small stone arrow-points. To obtain the basalt they make journeys up the mountains, where they break it fresh from the quarry, in which state they claim that it can be worked more easily than the material sometimes obtained by breaking up the large chipped points found in the vicinity. These they believe were made by the raven before there were men on the earth, and they call them "raven arrows." Thus, it would seem that at least the points were not made by the last few generations of the present tribe of Indians.

Two harpoon points made of antler were found. Each point had two barbs on one side; and the base, which was slightly wedge-shaped, was perforated.

Preparation of Food.—Pestles or hammers served for crushing dried meat, berries, and other food. They are of various shapes, made usually from fine-grained, tough river pebbles, and many are much weathered. Some are simply cylindrical, in which case they are usually but slightly changed from the natural pebble by a little pecking or rubbing.

The typical pestle of Lytton has a well-defined head, larger than the tapering body, the sides of which meet the base at nearly right angles. These pestles seemed to have been used for rubbing as well as pounding. One of them, a fine-grained schistose gneiss, shows no evidence of having been used for pounding, but its corners and base are smooth.

Slate knives were discovered in excavating graves and hearths. They are similar in form to those now used on the coast for cutting up fish. A spoon made from the shell of a unio was found in one of the graves. It was the only spoon-like object discovered, and was partly filled with a gum resembling that from the pine of the neighborhood.

Habitations.—The houses of the prehistoric people of Lytton were similar to those used by the Indians up to recent times. This is evident from the large number of ancient house-pits at all of the sites explored.

The Thompson River Indians, who inhabit this area at the present time, used to live in underground lodges. This lodge is made by digging a circular hole in the ground, and erecting over it a framework of timbers shaped like a cottage roof. These timbers are covered with fir-boughs and earth. Since there is but little rain, a roof of this kind offers sufficient protection. An opening is left in the center to serve not only as a chimney and window, but also as a door. A notched log—one end resting on the middle of the floor, the other projecting from this opening—constitutes the only means of entering the house.

When one of these houses goes to ruin, the circular pit is partly filled, but not enough to be entirely obliterated. It remains as a depression surrounded by a slight ridge. This ridge is composed of the earth and decomposed timbers of the roof. When the house is abandoned, much of the earth covering the roof slides down to the margin of the hole, where it accumulates, while the thin layer left on the roof only partly fills the room. Under the space where the composite door, window, and chimney were, the hole is left about as deep as ever, but may be partly filled with débris blown in by the wind.

For digging holes as well as for gathering roots the present Indians use a stick with a crutch-like handle. Such handles made of antler were found in the old village sites.

Tools.—Numerous wedges made of elk antler were obtained, which must have been very efficient for splitting timbers in the building of houses, for cutting firewood, and for general carpentry work. They were usually made from the large part of an elk antler, near its base, and cut off diagonally across. Some wedges which may have been used for special purposes were made of curved pieces of antler. They resemble in shape the curved wedges of the canoe builder of the coast Indians. The heads of some of the wedges are bruised and slivered by being driven with a stone pestle or maul. The use of a pestle for driving wedges gives it a concave base or one with a hollow in it. Rubbing tends to form a convex base. Some of the specimens have convex bases with a hollow in the center. It seems probable that pestles were used for a variety of purposes.

The common deeply-pitted hammer-stone was not found at this locality; but stone hammers or mauls were secured, that probably had been hafted in some way, and used on both ends. They have a slight pit on either side, and the two ends are battered. One small granite pebble has a groove which extends nearly around it, and which, if continued, would form a spiral. There is no evidence of its use as a hammer-stone. It may have been a sinker, or it may have been covered with skin or other material and used as a club head. In the latter case the tendency of the groove to a spiral form would allow a withe to be firmly attached.

Oval bowlders and flat pieces of sandstone were found which were probably anvils upon which to pound or to rub various substances.

The coast Indians use celts mounted as adzes for finishing the boards that have been split out with wedges. Until recently these celts were made with stone. Those found at Lytton are made of light green translucent material and vary in size from more than 4 inches in length by 1½ in width and ¼ in thickness, to scarcely an inch in length, with other dimensions in relative proportion. On some the grooves which were made in cutting them out of the blocks of raw material

still show slightly. Other specimens have been polished until no trace of these grooves remain.

These celts were made from bowlders of green stone secured along the river bank. Some of these are said to be nephrite. The series of specimens will illustrate their method of manufacture. Grooves are first ground or rubbed into bowlders. In some the grooves had been rubbed from both sides until a portion was nearly cut off, after which it had been broken away. Such selvage pieces broken off from large bowlders were found. A number of finished celts show this break along one or both edges. Fragments of siliceous sandstones with beveled edges that fit these grooves were obtained. They are evidently the saws or grinders used for cutting the grooves.

Whetstones, probably for sharpening celts, slate knives, etc., were made of fine grained schist. They were of frequent occurrence, and were usually found in a group of implements in graves at the main burial place.

Blades for small knives used in wood-carving were made from beaver teeth. The posterior side of the long curved tooth had been cut off, which made the tool thinner. The natural cutting edge of the tooth served as an excellent carving instrument. The base is rounded, and was probably inserted in a handle.

A knife-handle made of the rib-bone of some large animal was found in a grave with fragments of glassy basalt, one of which may have served as the blade. The end into which the blade was inserted is covered in places with gum similar to that of the pine. There are twelve notches or tally marks along the side, nearly obliterated by wear. The chipped point of the glassy basalt figured with this bone handle, although found on the surface apart from it, shows how well adapted the handle is to the common forms of stone points.

Pairs of coarse siliceous sandstone implements, sometimes daubed with red ocher, were frequently found in the graves and scattered among the traces of hearths and village sites. In general these resemble the arrow shaft smoothers found in other parts of the continent. They have the form of a half cylinder with a groove extending the length of the flat side. When a pair of these are placed with their grooved faces together, they form a cylinder about 6 inches in length, 1½ inches in diameter, and with a central bore ¼ of an inch in diameter.

Some fragments of skin, which were evidently portions of blankets or garments, were preserved by the dry climate and the action of copper salts. A considerable series of specimens was secured which suggests the preparation of skins and their manufacture into garments. Scrapers and awls made of stone and bone, and bone needles, belong to this series.

Skin scrapers were made of quartzite pebbles which occur in great numbers in the gravel on the bank of the river and on the mountain sides. Often almond-shaped flakes were broken from these pebbles. These pieces are about one-third the thickness of the original pebble. The finished skin scraper was simply one of these almond-shaped flakes which had been perfected by being chipped all round the edge.

Many scrapers of this sort, and some natural fragments of convenient form from neighboring out-crops, have been seen in use among the women of this region for softening skins. They were inserted in the split end of a wooden handle about 3 feet in length, and held there by winding with a thong that portion of the wood that held the stone. After the skin has been fleshed and freed from hair, it is stretched upon a framework of poles and prevented from becoming hard and stiff by being scraped and poked with such a scraper until it is thoroughly dry. Scrapers were also made of bone, but they were of another shape.

Several of them were found finished, and some in process of manufacture. In an ancient grave at Spences Bridge, 22 miles above Lytton on the Thompson River, a scraper of this kind was found with traces of wrapping at the ends. The Indians of to-day have a scraper of a similar shape, made from a horse's rib or a barrel hoop by winding the ends with rags to form handles. This they use like a draw knife to beam deer skins.

Awls and needles were required for the manufacture of garments. A pointed object made of steatite, about 1 inch long and ⅛ of an inch in diameter, smoothly polished, was found, as were also several natural pieces of chalcedony which may have been used for awls. The chipped specimens of glassy basalt and the chipped opalescent chalcedony more closely resemble what are usually called "drills" or "perforators." The bone awls are well adapted for use in sewing skins.

Needles made of bone, both fine and coarse, were found in the graves, and scattered through the ground. Each of them was provided with an elliptical eye, with its major axis lying in the axis of the needle.

War.—Many of the implements that were used for hunting were undoubtedly also used in warfare. The points for arrows, spears and knives certainly served either purpose. A number of special war implements have been found. A large knife or dagger made of antler, and much weathered by long exposure, was found on the surface of the main burial site; and from the excavations a much disintegrated war club of particular interest was secured. It was made of an elk antler. The prong near the base is beveled in the shape of a wedge, and the longer branch forms the handle.

A copper war club was obtained by Mr. James Teit from Indians who dug it out of a prehistoric grave at Spuzzum, B. C. This place is at the mouth of the cañon on the Fraser, 42 miles south from Lytton. The practical difficulties of the journey were great before contact with the whites; but the geographical nearness, and the fact that the present Indians of Spuzzum are of the same tribe as those of Lytton, induce me to describe this specimen with those from Lytton. Its edge is beveled, and in some places is knife-like. The grip and base are flanged by lateral pounding, and a design is engraved on each side of the blade.

Dress and Ornament.—Skins and garments woven of bark of the sage brush and of mountain goat wool probably furnished the material for clothing for the prehistoric people of Lytton. Fragments of deer skin and fabric woven from vegetable fiber, probably sage-brush, and a considerable number and variety of personal ornaments, were found. Red, blue, yellow, and white paint, and probably charcoal mixed with grease, were used for painting the body. Combs were in use, and body and clothing were decorated with ornaments and pendants of copper, stone, shell, bone, teeth and hair. A fragment of a comb made of antler came from the surface of the main burial place. It was much bleached and weathered.

A pair of copper ornaments was found in a grave a foot and a half deep at the main burial site. The body was so much decayed that it was impossible to see what position they occupied in relation to it. There are some pieces of hair preserved and embedded in the copper salts which incrust them. These ornaments resemble in shape similar copper objects which were used in recent times as hair ornaments for girls by certain tribes of the coast.

Other copper ornaments were found while excavating the main burial place, but the skeleton with which they were buried was too much decayed to distinguish the part of the body upon which they were worn. They are very thin, much corroded, and may have served as bangles or pendants. A number of pendants or bangles made of sheet mica were found in one of the graves which contained a great variety of objects.

Many irregular pieces of the shell of Pecten caurinus, with edges rubbed smooth and with one or two perforations were found in the excavation at the sixth site, and fragments of the same shell were found scattered on the surface of the fifth site. Some of them were daubed with red ocher. Several pieces of abalone shell, with squared edges, were found. One was perforated as a pendant. Such shell ornaments are now highly prized by the coast Indians on account of the irridescence of the shell.

Pendants made of the canine teeth of the elk were found in large numbers in the graves. Sometimes they were lying in the vicinity of the neck bones of the skeleton. The perforation drilled from side to side through the base of the root is usually worn smooth, and many of these objects are stained by copper salts. This again proves that ornaments made of copper were in use. Mr. James Teit has learned from the Indians that elk feet were often sewed on the garments, and also fastened to the prows and gunwales of canoes with string or gum. One pendant was made of the canine tooth of a wolf, perforated through the root for suspension, and ornamented with three grooves running around it.

Shell beads of various kinds were used for necklaces, fringes and the like. There are perforated disks or short cylindrical beads which average an ⅛ of an inch in diameter, a 1-32 of an inch in thickness, with a perforation about a 1-32 of an inch in diameter, drilled with a bevel from each side. Specimens of these shell beads were so numerous on certain parts of the surface of the main village site, that, after picking up a great many of them, their number seemed undiminished. Dentalium shells, and sections of these shells cut about ⅛ of an inch in length, were found, as well as little olivella shells, the ends of all of the latter being broken off, probably to make a hole for stringing. Some of these olivella shells had holes in the body near the lip, which, however, may have been merely accidental. In one of the graves some short cylindrical beads made of sections of dentalium shells were found still upon a portion of the string, which had been preserved by the dryness of the sand. According to identification by Mr. Willard N. Clute, this string is made of the bark of the red cedar. This material is more commonly used on the coast, and may have been imported with the shell beads upon it.

Several tassels made of dentalium shell and hair were found. These tassels are much stained by copper salts. A doubled lock of hair, held in the middle by a loop of string, the strands of which are twisted to the right, was pulled up into the shell.

Games, Amusements, Narcotics.—Sets of dice were often found with other objects at the sides of the skeletons. Although beaver-teeth, some of which were covered with red ocher, were found in the same places, and dice made of beaver teeth were secured from prehistoric graves at Kamloops, B. C., yet all of the dice found here were made from the teeth of the woodchuck. These are so much like the dice made of beaver teeth which the modern Indians of British Columbia use, that our knowledge of that game enables us to explain these specimens. The counting varies slightly at different places, but the game is practically the same.

The practice of smoking is indicated by the presence of stone pipes. The present Indians of this region mix bearberry with their tobacco to render it less strong for smoking. According to information obtained by Mr. James Teit, before the introduction of manufactured tobacco, the wild, narrow leaved tobacco of the region was used.

The pipes were made from steatite. Blocks of the raw material broken from the rock, and pieces of the same which had been cut and rubbed, were found on the surface. Finished pipes, highly polished, and ornamented with incised lines, have been found in situ in the old graves. The bowl of this style of pipe is of the shape of a wine glass, and the stem is simply an extension of the bowl, the axes of both being in a straight line.

Art.—The art of these people is illustrated by paintings, engravings, and carvings, and also by the ornaments used for personal adornment. A small bowlder was found on which there was a circle painted in red. Many pieces of bone, antler, etc., are also stained with red ocher, which may or may not have been intentionally applied.

The incised lines on some of the bone tubes that were found may have been intended as decorations. The handle of a digging stick made of antler bears an incised design at each end. The similarity of these designs to those used by the present Indians induced me to request Mr. James Teit to submit drawings of these specimens to several old Indians. Their interpretations are as follows:

The ladder-like design is a snake or worm pattern, which is intended to represent the striped skin of those animals. When used as patterns in ornamentation, these were generally drawn or carved without showing the head or tail of the animal. The two end designs on the large half of the handle represent a hairy insect. The long line with numerous short lines at right angles to it depicts a snake or a worm, which was probably the manitou of the woman who owned the handle, as it was customary for women having such guardian spirits to carve representations of them or their root diggers. Snakes, wood-worms, and other insects were among the manitous most commonly possessed by women in this region. The root digger and the thumbline were themselves the manitous of some women. The lines which cross each other probably represent cross-trails. The circular design on one specimen represents the butterfly or the eye. The short lines, with one very short mark extending from the middle of each, may be a sign of the wood-worm, as may also the long lines with marks at right angles to them.

It was customary for men to carve on their pipes, and chiefly on sacred pipes, representations of the beings appearing in their dreams, especially in their first important dream in which they received their manitou. Owing to the secrecy of treatment of sacred objects, it is difficult to obtain specific interpretations of such designs, for these secrets would be kept by the individual even from his friends, and with his death the knowledge of the significance of the design would pass away.

Among the present Indians the following conventional designs are frequently used. A long line and short strokes arranged at regular intervals perpendicular to it usually represent hair or something similar growing from a surface, as trees from the earth. Zigzag lines represent snake tracks; when they run down, they may mean lightning. Long straight lines represent trails, creeks, the earth, etc. The grouping of the patterns on such objects determines the meaning to a certain extent. The similarity of the art designs of the prehistoric people to those of the present natives is the strongest argument in favor of the theory that the culture of this area has not materially changed since the times when the prehistoric burial ground of Lytton was in use and the prehistoric sites were inhabited.

Pipes made of steatite, besides being engraved, were sometimes carved. On some there is a ring about the tube where the bowl joins the stem; on others there is a mouthpiece with incised ornamentation. The bowl of a pipe, a fragment only of which was found, was in the form of a head of an animal with its mouth wide open. The material is steatite. A very beautiful animal form carved in antler has a hole drilled through it, tapering from below upward; and another hole from the posterior end of the carving runs forward about ½ of an inch. The legs stand out in relief, while the stripes on the sides are incised. The piece has been broken or decayed in such a way that it is impossible to tell how much, if any, is lacking. A head of the same style of carving, in the same material, was found. These carvings so closely resemble each other that one may easily be taken for a fragment of the other.

These animal carvings are entirely different from the engraved designs, and of a high order of art, which resembles that of both the old and recent coast culture perhaps more than anything else found near Lytton.

No specimens of the ceramic art were found. The modern Indians boil food by dropping hot stones into water-tight baskets containing it.

Method of Burial.—Dr. Dawson, in his notes on the Shuswap, refers to bodies found buried sitting upright, and to others lying upon the side. In still other cases he found a few bones placed in such a manner as to suggest that they were buried after the decomposition of the soft parts. Dawson* saw the Indians in Nicola Valley reburying a body that had been dead for about a year. He found the heads of many bodies covered with red ocher, which still adhered to the skull when it was taken up. He considers that the objects buried with the dead were to represent their property rather than to be of any future use to them. For instance, flakes of glassy basalt and crooked arrow points would represent property, though in themselves of little value. Quartz crystals, calcite, mica, and stone objects resembling slate pencils were found. He saw no iron, and believes that some of the graves at least antedate the coming of the whites to the west coast of America. The bones of small animals and bear teeth indicate that some were hunters, and the stone adzes suggest canoe manufacture. At Lillooet, about 40 miles to the north, Dr. Dawson discovered beads or pendants of galena, and many flat bone beads such as were frequently found by us at Kamloops, but which we did not see at Lytton. He found bodies at Lillooet wrapped in bark.

We did not find any grave in which the body was in a sitting posture. The description of a few graves will serve as examples of the types of graves found by us. In one of them the head was to the east and the pelvis to the west. The feet were drawn up to the pelvis, so that the knees were in front of the chest. The head rested on the right side. The arms were flexed parallel to the body, with the hands to the face. The whole body rested horizontally. The depth in the shifting sand was a foot and a half, that originally may have been a few inches or from 10 to 15 feet, according to the changes in the superimposed sand caused by the wind. There was a knife made of a beaver tooth at one knee; and many implements of antler and a beaver tooth were in such a position as to suggest that they had been placed in a pouch. This bundle of objects extended in the direction from knee to face.

In another burial the skeleton lay with the head to the north. The body and head were covered with birch bark. Red paint was found at the shins; and white and yellow paint, 6 inches east of the pelvis, or one foot east of the heels. The heels were toward the south, the face toward the west. The body rested in a horizontal position on its right side. The hands were over the face and forehead. Near the chin were dentalia, copper covering a wooden cylinder, as well as pieces of loose copper, and perforated elk teeth stained by the copper. A nephrite celt was secured from below the lower end of the left femur, with the sharp edge toward the east. Charred berries were found above the shoulder. Six inches east of the head were an arrow point, roughly chipped points, chips, a little nephrite celt, red paint, bone needles, and other implements, a knife point made of a beaver tooth, and animal teeth. Five inches east of the middle of the back a long celt was found.

The skeleton of a young adult lay with head to the north. The body had been flexed as usual. The face was to the east. Little black arrow points were found throughout the grave. Some beaver teeth and red paint were found between the middle of the tibia and the femur of the right leg; the left leg was not flexed quite so close as the right.

* Transactions of the Royal Society of Canada, Section II., 1891, p. 13.

A group of antler implements and chips of black stone, probably the contents of a pouch, were located a few feet east of this grave, and four inches directly west of another skeleton of an older individual, which faced west, with the head to the south. The latter skeleton was disarranged either by the wind or because it had been reburied. With it were found chipped points of stone and pieces of the same material, a pair of grooved arrow-shaft smoothers, three whetstones, several finely-carved pieces of antler, bone awls and needles, a bone scraper and pendants, dice made of woodchuck teeth, white paint, pendants of mica, and bits of birch bark.

Grotesquely formed pebbles of various bright and clear colors were sometimes found in the graves, and these may have been prized as amulets or charms. There were some irregular piles of human bones. In the typical graves the bodies were buried upon the side, with the knees drawn up to the chest. They were often covered with pieces of birch bark, as was evidenced by small fragments preserved by the dry soil. At the side, in a position indicating that they were buried in a pouch, were found pieces of glassy basalt, points chipped out of the same material, celts, and a number of other implements, varying with each grave. Near the neck elk tooth pendants were frequently found.

Closely rolled pieces of birch bark varying from 1 to 6 inches in length, rolled to a diameter of from ½ an inch to 1 inch, were found in the hearths, scattered over the village sites and over the graves. Whether these originally had paintings or drawings on them is not known. Many of them have been partly burned, which suggests their use as torches.

Pieces of birch bark were sometimes buried with the dead by both the Thompson River Indians and the Lillooets. The latter tribe now extends from some 40 miles above Lytton into the valley next, west, as far south as Harrison Lake. The Lillooets formerly wrapped some of their dead in birch bark, and often lined the graves with the same material.

Conclusions.—The prehistoric culture of the interior of British Columbia, as evidenced by finds at Lytton, Kamloops, and Spences Bridge, was quite uniform, although there may have been slight variations in these localities. On the whole, this culture resembles that of the present inhabitants of the interior of British Columbia. The mode of life of the prehistoric tribes, their utensils, their methods of manufacture, and even their customs must have been practically the same as those of the recent Indians. One of the strongest evidences for the identity of culture is the ability of the modern Indians to interpret the conventional designs found on prehistoric remains.

There are, however, slight differences between the prehistoric and the recent cultures. These are indicated by the change in the style of arrow heads, which were much larger among the prehistoric people. The ancient type of pipe resembles the prehistoric pipe of Oregon and California, while the recent pipe is practically of the same type as that found on the plains. No indications were found suggesting that the prehistoric tribes knew the potter's art, which, up to the present time, is unknown in this area.

The style of carving exhibited in some of the specimens suggests that at this early time the people of the interior of British Columbia were influenced by the coast tribes, who have developed a very high plastic art. The use of slate fish knives and harpoon points may be due to the same cause. The occurrence of dentalium and olivella shells, and of pendants made of the shell of Pecten caurinus and abalone from the Pacific Coast, proves the existence of inter-tribal trade in that direction. On the whole, however, the prehistoric culture of the interior of British Columbia shows greater affinity to that of the western plateaus than to that of the North Pacific coast. Up to this time we have no evidence of a change of type or of a material change of culture since the earliest times of which we have knowledge.—Monumental Records.

## AMERICAN ENGINEERING COMPETITION.*

### I.—INTRODUCTORY.

AN Englishman visiting the United States at the present time can hardly fail to be impressed by his own countryman's want of knowledge of the growing manufacturing industries of America and the indifference displayed by British manufacturers toward the increased rivalry to which they may any day be subjected from across the Atlantic—a rivalry which will surely come as soon as the present excessive home demand in America slackens.

To realize thoroughly the importance of this competition it is necessary to visit America; to see the size of the factories, the completeness of their plant, the way in which the men work, unchecked by artificial restraints or trade union regulations, the enterprise of employers, and, lastly, the natural resources of the country. Some guidance may be obtained, however, from published figures, and it will be the object of these articles to give information upon the subject of American engineering competition, both from knowledge gained by means of official statistics, and also from the results of personal observation. It will be evident that among the figures referred to those of chief interest relate to the imports and exports of the two countries. That will be more especially the case in dealing, as far as published figures will allow, with manufactures which form the subject of these articles, and which this country has always looked to for bringing that foreign trade essential to our existence as a great nation. We will, however, first glance at the matter in the gross.

In the two statistical abstracts issued respectively by our own Board of Trade and by the United States Bureau of Statistics we find, in more or less convenient form, the figures relating to the foreign trade of the two countries. To go back over ten years—the American fiscal year ends June 30—the total exports of the United States were in 1888, $695,954,507 (£144,990,000), of which about $12,000,000 were for foreign goods; while the imports were $723,957,114 (£150,791,000). That gives an excess of more than $28,000,000 of imports over exports. In 1898 the American exports had gone up to $1,231,482,330 (£276,546,000), while the imports had fallen to $616,049,654 (£128,343,000). Therefore, instead of buying more than they were selling, as in the first named period, the Americans were selling more than they were buying, and that to an enormous extent. Turning to our own figures, we find that in 1888 our total exports were £298,577,541, of which about £64,000,000 were foreign and colonial goods. This may be compared with £144,990,000 for America (dollars being reduced to pounds sterling), so that our exports were double those of the United States in 1888. Our imports for the same year were valued at £387,635,743, as against £150,824,000 for American imports. Our excess of imports over exports was, therefore, more than £89,000,000. Both countries eleven years ago imported more than they exported. By 1898 our exports had fallen to £294,013,988 in value, but our imports had risen to £470,378,588; so that the excess of imports over exports had risen to £176,364,595. It will be seen, therefore, that in this latter year, while we, according to the official figures, bought £176,000,000 worth more than we sold, the Americans sold over £128,000,000 worth more than they bought. This is according to official figures; but in 1898 the value of ships built in the United Kingdom for foreign owners was not recorded. This was certainly not fair to our export trade, as a steamship sold abroad represents considerable industrial activity. In the latest returns this matter has been put on a more satisfactory basis, and we find that for the eleven months ended November 30, 1899, new ships, including machinery, to the value of £8,562,922 were sold for abroad.

Sir Robert Giffen, in his admirable and most timely monograph read before the Royal Statistical Society, taught us not to be too easily alarmed by an excess of imports over exports, because we had to the good ocean freights and the return on our invested capital in railways, public works, etc., abroad. There are some who go further and say that imports are a sufficient indication of industrial success, for if we did not have the wealth we could not spend it, and the possession of wealth is the measure of material prosperity. It is an easy thing to push an argument like this to an extreme which would be misleading; but, in any case, it is plain that for a country to carry on an export trade is an indication that it can meet and beat other nations in competition. That is the practical point we have to deal with just now. Moreover, the falling off in American imports—though it may be caused by a protective tariff—is evidence of the nation's greater ability to manufacture for its own needs, and for the consumer to pay the price demanded by the producer, always provided that the people are supplied with the comforts and luxuries of civilization, as the Americans undoubtedly are, and that to a remarkable extent.

It is, perhaps, a little misleading to deal with crude statistics in this wholesale fashion. For instance, to give a just idea of the bulk of business done, it should be stated in terms of the population, for it is evident that, the greater the number of people, the less must be their proportionate share of the advantages derived from a given volume of trade. When the figures are looked at in this way, the still existing industrial supremacy of Great Britain is apparent. The American returns for 1898 give "merchandise imported for consumption" at 38s. ($7.89) per head, while our proportion of imports per head of the population is £11 14s. 1d. Turning to exports, we find that the United States sent out of the country in 1898 domestic merchandise to the extent of £3 7s. 9d. ($16.27) per head, of which 70·24 per cent. was agricultural produce and 24·02 per cent. consisted of the products of manufactures. We exported per head to the value of $5 16s. 2d. for the same year.

Such figures as these, however, valuable as they are, tell but a part of the tale, and are apt, as has been said, to be misleading unless used with discretion. Those who rely wholly on statistics lean too much on the past. They think that, when their tables do not supply instances, instances cannot exist. Such an attitude ignores change and the possibility of change; it is as if Adam had forecast the coming birth-rate upon data collected before the Fall. That is an attitude the British mind is a little too apt to take.

British manufacturers and merchants ought not, therefore, to trust overmuch to "returns." They should visit other countries, more especially America, to see what facilities there are for production in this new land, and what sort of people it is with whom they will have to cope. That, however, is just what they will not do. Hardly any Englishmen go to the United States for observation and instruction in the way that Americans come to Europe.

Since England built up her industrial supremacy a new race has risen. Probably ethnologists do not give it a place in their classifications, but for industrial and economic purposes it is a new race; just as the Anglo-Saxon was a new race when it founded our Empire. We in England, who are proud of our relationship with America, are fond of speaking of this new and, industrially, most puissant people (who should really invent a generic title for themselves), as "of the Anglo-Saxon race." This is true so far as that the stiffening of the people comes from Anglo Saxon ancestry. But the blood has been so blended by crosses from all peoples of the world, and, moreover, the environment of the race during its infancy and later growth has been so different from anything that has attended the progress of any other nation, that the character of the people is sui generis, a race apart, a fact which would be more apparent to Englishmen were it not for the common tongue. The history of our industrial success in the past may interpret much of the present success of America. Our commercial supremacy has been built up largely by foreign immigration. What religious persecution and political oppression abroad did for us in the past, free emigration is doing for America in this present day. It is producing a people so versatile, so farseeing, and so enduring in effort that the very forces of nature seem to take more plastic shape in their nervous hands.

If we turn from personnel to matériel, we find the United States especially favored by nature in the distribution of her gifts. The keystone of a general manufacturing industry is engineering, and this again is founded on pig iron.

For the successful making of pig iron, ore, coal, and flux are needed; and it used to be commonly said that the engineering supremacy of Great Britain would never be threatened because of her natural advantages—ironstone, coal, and limestone near together, and all close to the sea. Other countries, we used to say, might have one or the other, but more or less widely distributed, and not near a port. In 1874 Mr. A. L. Steavenson, of Durham, said, at a meeting of the Iron and Steel Institute, when speaking of the great Cleveland iron district, "rival claims to be the leader in producing iron have been made, but we have seen nothing yet in any of these to cause the least anxiety." So far as knowledge went there was truth in this, but prospectors, inventors, and others have brought things about that have changed the situation. Our coal has been getting deeper and more difficult to win. Much of our ore has been worked out, or is found to be unsuited for modern processes.

On the other hand, in foreign lands richer ores have been found and worked. The Lake Superior ores contain from 59 per cent. to 65 per cent. of iron, while the Gellivara mines of northern Sweden give a 69·51 per cent. ore. Even our rich Cumberland and Lancashire hematite ores have but 57·60 per cent. of iron, while the Cleveland ironstone is very much leaner. Abroad, again, coal is being worked nearer the surface, and, where long distances have to be covered to bring the materials together at the blast furnace, improved engineering practice and commercial enterprise have enabled our foreign competitors to overcome what seemed formerly insurmountable obstacles. This is particularly true of America, as will hereafter appear.

So far from our own coal, ironstone, and flux being together, nearly the whole of the ore for a most important make of iron, i. e., that used in the manufacture of Bessemer steel or mild steel—is brought a thousand miles over sea from Spain. Thus, in 1898, there were produced in the United Kingdom 8,631,151 tons of pig iron of all kinds, and during the same year we imported close upon 5,500,000 tons of ore, chiefly from Spain. The reason of this shifting of our field of supply to a distance is, of course, well known. It is that the greater part of our native ores contains too much phosphorus for producing iron suitable for the manufacture of Bessemer and Siemens steel by what is known as the acid process; and, as yet, the acid process is the one preferred in Great Britain. Figures bearing on this will be given later in these articles. It is hardly necessary here to dwell on the supreme importance of steel of the descriptions named in modern engineering construction. Mr. Andrew Carnegie has recently said that "The city or the nation that can produce the cheapest ton of steel has insured supremacy; the cost of so many other articles depends on the cost of this prime element." Mr. Carnegie is himself, above all, a steelmaker, but that does not make his statement less true. For the ore from which this valuable material is made we in England are chiefly dependent upon foreign mines, so far as acid-made steel is concerned. In regard to the more modern basic process, it will be sufficient for the present to say generally that the original acid process of steel making demands a non-phosphoric ore, such as the Spanish ore, while, with a basic-lined furnace, our native ores, comparatively high in phosphorus, can be used. In spite of this, by far the greater part of the steel produced in this country is made by the acid process, it being reserved for Germany and the United States to take the lead in the production of that British invention, basic steel.

Up to about ten years ago Great Britain had always held the premier position among the iron-producing countries of the world, but in the year 1890 the United States wrested the lead from us, and, except for two years, has held it ever since. Fifteen years ago our production of iron was double that of the United States. Now, as will be seen, we are far behind; and there is every indication that within five years, possibly much less, the blast furnaces of America will produce twice as much iron as those of Great Britain.

The following table gives figures taken from official sources:

PRODUCTION OF PIG IRON.

| Year. | United Kingdom. | United States. | + or — U. K. to U. S. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| 1884 | 7,811,627 | 4,097,869 | + 3,713,858 |
| 1885 | 7,415,469 | 4,044,526 | + 3,370,943 |
| 1886 | 7,009,754 | 5,683,329 | + 1,326,425 |
| 1887 | 7,559,518 | 6,417,148 | + 1,142,370 |
| 1888 | 7,998,969 | 6,489,738 | + 1,509,231 |
| 1889 | 8,322,824 | 7,603,642 | + 719,182 |
| 1890 | 7,904,214 | 9,202,703 | — 1,298,489 |
| 1891 | 7,406,064 | 8,279,870 | — 873,806 |
| 1892 | 6,709,255 | 9,157,000 | — 2,447,745 |
| 1893 | 6,976,990 | 7,124,502 | — 148,512 |
| 1894 | 7,427,342 | 6,657,388 | + 769,954 |
| 1895 | 7,703,459 | 9,446,308 | — 1,742,849 |
| 1896 | 8,659,681 | 8,623,127 | + 36,554 |
| 1897 | 8,706,765 | 9,652,980 | — 856,213 |
| 1898 | 8,609,719 | 11,773,934 | — 3,164,215 |
| 1899 | *9,500,000 | †14,000,000 | —†4,500,000 |

* This is the product that has been estimated but, to judge by later advices, it will probably be about half a million tons too high.

† Estimated. The figure is, however, higher than will be realized.

So far as domestic use is concerned the figures relating to America need not touch British ironmasters very closely, for we long ago ceased to look on the United States as a market for our iron, owing to the protective tariff which forms so prominent a feature of American policy. With an ever-growing population and such vast tracts of country being rapidly developed, the home demand for iron in America must continue to be enormous, and so long as production does not outstrip demand British makers may look on this growth with indifference, knowing they neither gain nor lose. The case will be entirely different, however, when the American makers produce more iron than is needed in their own country, and, as a consequence, have to seek a market abroad. To some extent this has already come about, for pig iron has been sent to Europe, while iron and steel in their manufactured state have also been largely exported from the United States. At the present moment, however, American

* This series of articles, written after a special tour of the manufacturing States of the Union, will appear regularly in successive issues of the SUPPLEMENT.

manufactures of all classes have more than they can do to keep pace with the home demand, and this is more especially true of iron and steel makers. During a tour through the chief manufacturing States of the Union, made for the purpose of writing these articles, I found everywhere the same tale of booming prosperity, works of all kinds full of orders for a year or more ahead; old works being enlarged and new works being started. Never anywhere has there been such a period of commercial expansion since the factory system was established. Naturally in this way supply and demand act and react on each other, so that the ball may be kept merrily rolling for a long time yet. But some day, sooner or later, the inevitable will come about, and America will awake to the fact that she has more blast furnaces, more steel mills, more factories of all kinds than the country demands for its existing needs. That is an old, old tale with us; for the ebb and flow of trade seems as inevitable as tides to an ocean.—London Times.

## POLAR LIGHTS.

WE are accustomed to consider the weird coruscations which light up the long dreary nights of the Arctic regions as a phenomenon connected in some way with the electrical condition of our globe, says Engineering. We are led to this consideration by the action which the flickering streamers of this curtain of light exert on the magnetic instruments of our observatories and the lines of our telegraph systems. The auroral display of November 17, 1882, has, for instance, not yet been forgotten. In the United States its influence was felt throughout the day, from California to the Atlantic seaboard. The night of February 13, 1892, is hardly less memorable, the aurora which occurred being extensively observed in the United States and in some parts of Europe. Telegraphic communication between New York and Albany was maintained at times without batteries; the current, however, often became intermittent, and even unmanageable, so that for nearly two hours it was extremely difficult to transact business with anything like satisfaction. The telegraph system of Sweden was also paralyzed, and Russia felt the effects of the great magnetical disturbance. At Kew the declination needle swung 2 degrees away from its normal position; the horizontal force changed from ·1760 degrees to ·1830 degrees, and the vertical force from ·435 to ·442. It is interesting to notice that the brilliant aurora of 1882 took place just when a tremendous storm broke out on the sun, as evidenced by the appearance of a spot which covered no less than ·00247 of the sun's visible surface. In like manner, that of 1892 corresponded with the appearance of another stupendous spot. The connection between the solar activity and auroral displays is very marked, both having a regular cycle of 11 years 2 months. It is also significant that the changes in magnetic declination have the same period of 11 years. We have here a physical problem of surpassing interest, and, therefore, also of exceeding difficulty. It has been studied by many, from De la Rive down to Nordenskiold; and it still proves so attractive to the veteran auroral student, Dr. Paulsen, of Copenhagen, that he has gone to a little village in Iceland, where, with the help of a number of physicists, he hopes to make an exhaustive study of the aurora in its native home, and to test some of the theories that have been put forward to explain this mystery of the sky. Two stations have been selected—one at the village of Akureyri on the northern coast, and the second on the top of a neighboring mountain. The two stations are connected telephonically. The party are equipped with the most recent electrical and photographic instruments, and have been well drilled in operating them.

**How to Make and Use French Polish.**—There is, as in many other things, a right and a wrong way of using French polish. It is rather difficult in a short paragraph to give instructions for polishing. There are so many things connected with it that can be gained only by experience. In the first place, the wood to be polished must be made perfectly smooth and all irregularities removed from the surface with glass-paper; next oil the work with linseed oil, taking care to well rub off all superfluous oil. (If the wood is white no oil should be used, as it imparts a slight color.) Then prepare a wad or rubber of wadding, taking care there are no hard knobs in it. After the rubber is prepared pour on it a small quantity of polish. Then cover it with a piece of old cotton rag (new will not answer). Put a small drop of oil with the finger on the surface of the rubber, and then proceed to polish, moving the rubber in lines, making a kind of figure of eight over the work. Be very careful that the rubber is not allowed to stick or the work will be spoilt. A little linseed oil makes the rubber more free in working. When the rubber requires more polish, turn back the rag cover, pour on the polish, replace the cover, oil and work as before. After this rubbing has proceeded for a little time and the whole of the surface has been gone over the work must be allowed to stand for a few hours to harden, and then be rubbed down smooth with very fine glass-paper. Then give another coat of polish. If not smooth enough, glass-paper again. This process must continue until the grain is filled up. Finish off with a clean rubber with only spirit on it (no polish), when a clear bright surface should be the result. Great care must be taken not to put the polish on too freely, or you will get a rough surface. After a little practice all difficulties will vanish. The best French polish will be found to be one made only from good pale orange shellac and spirit, using 3 pounds of shellac for each gallon of spirit. The latter should be of 63 to 64° over-proof. A weak spirit is not suitable and does not make a good polish. A few drops of pure linseed oil makes the polish work more freely.—Oils, Colours and Drysalteries.

**Fire-Proof Paper.**—To render paper fire-proof, it is saturated with a solution of

| | |
|---|---|
| Ammonium sulphate | 8 parts. |
| Boracic acid | 3 " |
| Borax | 2 " |
| Water | 100 " |

For the same purpose sodium tungstate may also be employed.—Die Werkstatt.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